Study on Utilization of Geographic Information System in School Education in Japan

Yuda Minori

January 2009

Dissertation

Study on utilization of Geographic Information System in school education in Japan

Graduate School of
Natural Science & Technology
Kanazawa University

Major subject:
Environment Science
Course:
Environment Planning

School registration No.: 0423142426
Name: Yuda Minori
Chief advisor: Prof. Itoh Satoru

Abstract

The Geographic Information System (GIS) has rapidly spread into society since the 1990s. Meanwhile, the potentials of GIS utilization have been pointed out in the education field including school education. However, GIS has not been introduced into classes yet.

This dissertation examines the possibilities of using GIS in school education in Japan from different aspects, such as understanding the nature and problems of the Japanese national curriculum standards from the viewpoint of introducing GIS into school education, the characteristics of students as future potential GIS users, the development and evaluation of Cellular Phone GIS on the basis of users’ needs and characteristics, and awareness of Finnish education as a successful case in introducing GIS into school education.

In Japan, most upper secondary school teachers have hardly ever used GIS in class. The national curriculum standards do not include any mention of GIS or learning content relating to the basics of map literacy and map skills.

The results of the surveys on the map literacy of students showed that their accuracy in map reading was related to their level of spatial cognition, number of reference points used and experience in studying and reading maps.

Applying these findings, the development and evaluation of “Cellular Phone GIS” for fieldwork in school education were conducted. Through experiments with lower and upper secondary school students, it was confirmed that Cellular Phone GIS helped them to do the fieldwork and classes after the survey went smoothly. It encouraged the students to participate in classes and provided them with opportunities to consider their findings from many perspectives.

Also, Finland was taken up as the case of a country that successfully introduced GIS. The strategies for Finnish education included the educational curricula to develop students’ map reading skills to enable them to use GIS by themselves in upper secondary school, training for teachers in the new content of education, improvement of the conditions surrounding GIS software and cooperation with other countries.

Through the dissertation, it became clear that the national curriculum standards and their educational content, education and training for in-service teachers and university students as future teachers and development of GIS to solve the problems in class would be the key to installation and utilization of GIS in school education.

Acknowledgements

About 6 years ago, I first came across the problem of GIS in education. At the time, I was working in the Institute for Areal Studies, Foundation in Tokyo as a researcher, and the institute organized a consortium to promote use of GIS in the education field. I joined the management staff of the organization. Many companies and teachers who recognized the effectiveness of GIS joined the organization and discussed how to spread GIS in classes. At that time, I had already studied the concept of GIS and its operation in graduate school. In fact, I did not think it was such a problem that GIS had not been widely accepted. But as I learnt more about the problem, I realized that it was a bigger and more profound matter than I had imagined. In fact, GIS in education is connected to the future of society. I started to think that this issue should be studied more responsibly in order to educate children who will lead the world in the future. Then I met Prof. Itoh Satoru, a distinguished urban geographer and specialist in GIS education and seriously started this study in Kanazawa.

I must say that I would never have returned to graduate school and gained such experience at Kanazawa University if I had not met Prof. Itoh, my supervisor who has helped guide my research since then. I cannot find the words to express my gratitude. Without his suggestions, invaluable support and encouragement, it would have been impossible for me to study this topic in Kanazawa while working in Tokyo. I would like to extend my deepest gratitude to him.

In addition, Kanazawa University gave me the invaluable opportunity to study at Helsinki University of Technology in Finland as an exchange student for one year from August 2005. With financial support from the university and the Yoshida Scholarship Foundation, I gained invaluable experience in that country. I would like to say thank you to both universities and to the foundation for their support. And I sincerely thank Prof. Kirsi Virrantaus and all her colleagues in the laboratory of cartography and geoinformatics (the present laboratory of geoinformation and positioning technology) in the Department of Surveying for supporting and encouraging me to study GIS and Finnish. Regarding GIS in school education, I was able to work with Dr. Tino Johansson of the University of Helsinki. I really appreciate his incalculable help with my research in Finland. I also thank everybody who helped me when I was in that country. Kiitos kaikille.

I would like to express my appreciation to everyone who helped with my experiments in this dissertation. I am especially grateful for the help given to me by Mr. Kizu Yoshinaga and Ito Junya of TG Information Network Co. Ltd., Uchida Hitoshi of Takasaki High School in Gunma Prefecture and Moroda Takeshi of Tamamura Minami Junior

High School in the development of Cellular Phone GIS and the practical exercises using the system in classes. I am truly grateful for their cooperation.

In Kanazawa, I was extremely fortunate to have a wonderful education environment in the Department of Geography of the Faculty of Education. I would like to thank the laboratory staff and all the students there.

I would also like to extend my gratitude to Prof. Kawakami Mitsuhiko, Associate Prof. Shen Zhenjiang and Prof. Kamiya Hiroo of Kanazawa University and Associate Prof. Okunuki Kei-ichi of Nagoya University for being members of my dissertation review panel and for all the valuable comments they provided.

Ms. Colette Yamamoto helped to correct my English. Her efforts made my dissertation better and clearer. I really appreciate her help.

While working on this dissertation, I became aware of just how much my friends cheered me up and worried about me. I would like to sincerely thank them for their kindness.

I would also like to give my sincere thanks to my parents and sister. This achievement would not have been possible without them. They not only respected my decision but also helped and encouraged me all the time. I appreciate so much their unfailing love and trust in me throughout my life.

Yuda Minori
Kanazawa
January, 2009

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Chapter 1. Introduction

1.1 Background of the study

The Geographic Information System (hereinafter called GIS) with functions such as capturing, storing, analyzing, managing and presenting data that refer to or are linked to location has rapidly spread into society since the 1990s. Recently, GIS has become more accessible because car navigation systems, web-mapping applications and other services using GIS have come to be accepted in society. Nowadays, GIS is a social infrastructure. GIS applications are tools that allow users to create maps easily, display and output attribute data and media files such as images, movies and sounds on maps, and analyze spatial information (Kohsaka and Sekine 2003). The potentials of GIS utilization have been pointed out in geography which deals with maps, as well as in social studies, earth science, environmental studies, and ultimately, in all subjects in primary and secondary school education.

The necessity of introducing GIS into education has been discussed mainly from two dimensions. One is that the functions of GIS will contribute to development of “the ability to learn and think independently by and for oneself” which is emphasized in the national curriculum standards (Ministry of Education, Culture, Sports, Science and Technology; MEXT 1998a, 1998b, 1999). Today’s primary and secondary education expects maps which visualize phenomena not only to provide knowledge to students, but also to make students understand things in relation to others.

The other dimension concerns training present and future users of GIS as a social information infrastructure. Utilization of GIS requires skills in computer operation, map reading, data analysis, interpretation and so on. From the point of view of developing human resources to support society, it is considered worthwhile to introduce and utilize GIS in school education.

Previously, both GIS software and spatial data for GIS used to be so expensive that only limited users could buy them. However, data sharing using maps as a function of GIS attracted attention following the Great Hanshin-Awaji Earthquake in 1995. Since then, GIS has been regarded as “an important intellectual infrastructure in the advanced information society” (Chiri joho shisutemu (GIS) kankei shocho renraku kaigi 2003). The Japanese government took the initiative of collecting and standardizing data, and nowadays, many such data can be obtained freely via the Internet. Also, many freeware or inexpensive shareware GIS applications with excellent functions can be downloaded from the Internet. Furthermore, the “e-Japan strategy” was launched by the Japanese government in 2002, with the result that the computer and network environment in schools was dramatically and rapidly improved.

Nevertheless, such improvement of the GIS environment has brought neither a tremendous increase in GIS users in schools nor dramatic changes in school education.

1.2 Research purpose, methods and structure

The purpose of this dissertation is, for further utilization of GIS in school education, to clarify the effectiveness and problems of GIS in education and ascertain the future direction of introducing GIS into school

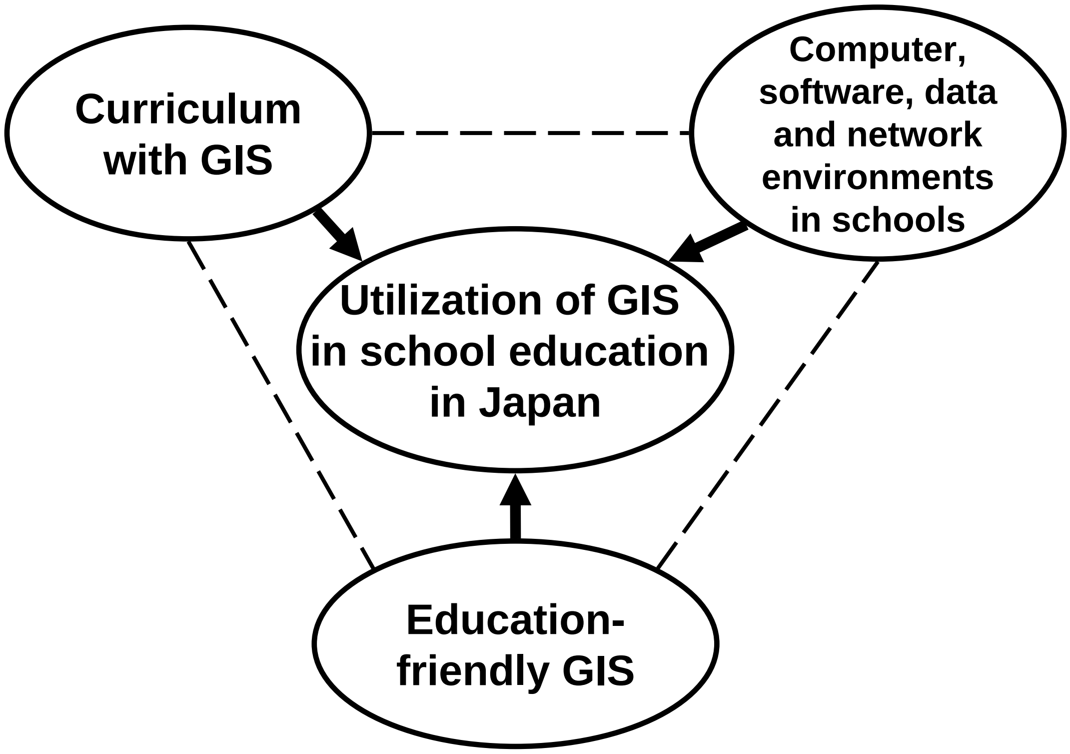


Figure 1-1 Framework of introducing GIS in school education

education from various perspectives.

The hypothesis of this research is that the school environment including the education curricula, the computer, software, data and network environments and the installation of education-friendly GIS will make it possible to utilize GIS in school education in Japan (Figure 1-1).

Based on this fundamental assumption, this research clarifies the actual conditions and background of GIS in school education from teachers' opinions and the Japanese educational curricula. Classes using GIS developed for utilization in classes are conducted and evaluated by students. Furthermore, the research tries to identify the method and background of introducing GIS in a successful example. From the findings in these approaches, the direction of utilizing GIS in school education is discussed.

The structure of the dissertation is illustrated in Figure 1-2. In Chapter 2, the author conducts a questionnaire survey of Japanese upper secondary school teachers to clarify the extent to which GIS is actually used in class and to discover the current status and background of using GIS in school education. The situation of GIS in Japanese school education is also considered from the perspective of the national curriculum standards.

In view of these facts, in the next phase the author considers how to develop GIS for use in school education. To develop GIS for school education, it is necessary to understand users' characteristics, develop GIS itself and practice and evaluate the developed GIS.

GIS users in school education are teachers and students. To develop GIS based on consideration of the characteristics of students as the main users,

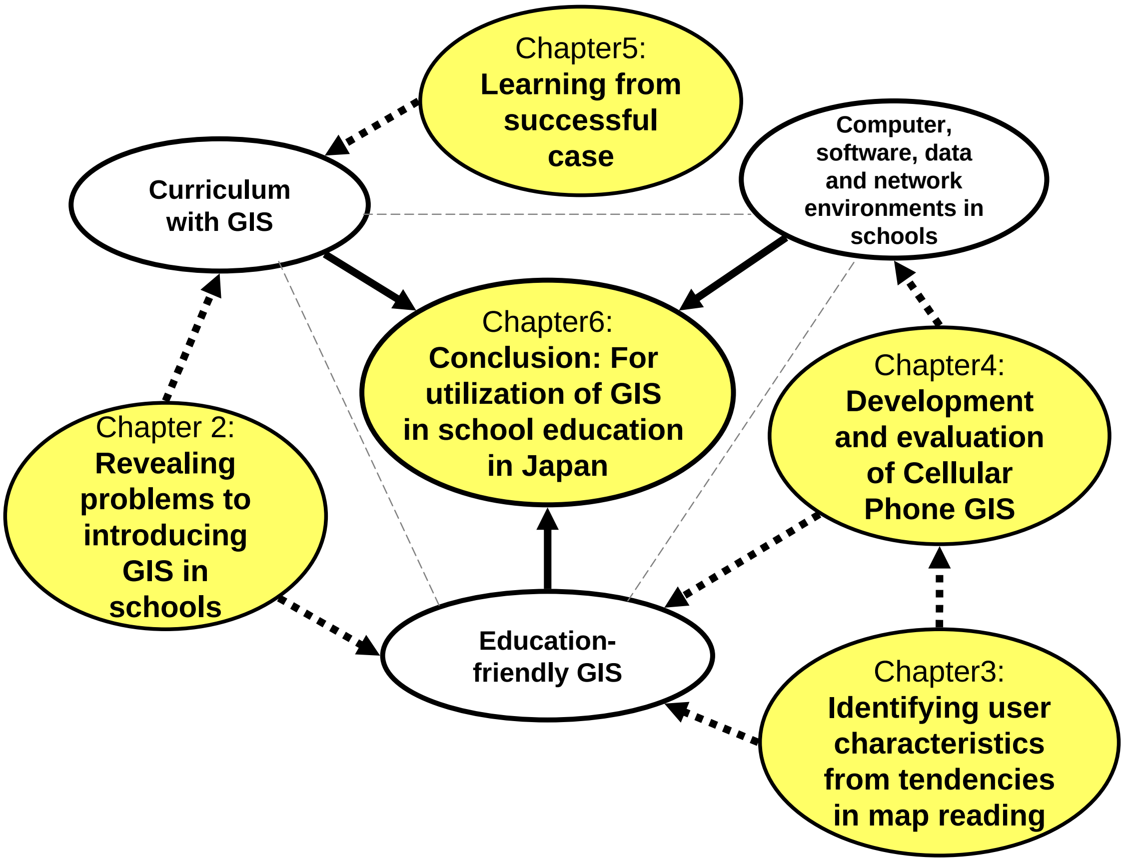


Figure 1-2 Structure of the dissertation within the framework of introducing GIS in school education

the author sets out to clarify how accurately they can read maps and what reference points they use to read maps by age in Chapter 3.

In Chapter 4, the author explains the development of GIS with consideration for the needs of school teachers and the characteristics of students, and practices this developed GIS in classes from lower secondary school to university for evaluation by the students as users. This is the development of “Cellular Phone GIS,” an integrated system of mobile phones and WebGIS.

In Chapter 5, to consider a case in which GIS has been successfully introduced into school education, the author focuses on Finland. The actual state of Finnish teachers’ usage of GIS is clarified by questionnaire and the background of introducing GIS in school education in Finland is observed from many aspects.

In Chapter 6, the author summarizes the findings and contributions of the dissertation and discusses the need for introducing and utilizing GIS and for future research.

1.3 Previous researches

1.3.1 Research on introducing GIS into school education

Introducing GIS into the education field, especially into primary and secondary education, has been discussed all over the world for more than a decade. Many scholars believe that GIS will contribute to quality in education because GIS has the educational effectiveness (Bednarz 2004) of developing students’ spatial cognition and helping their decision making processes (MacEachren 2000, Sugumaran et al. 2004) as well as increasing students' motivation to learn (West 2003). Even in the United States, where utilization of GIS in class has been promoted progressively, the fact that use of GIS has failed to become established in schools has often been reported (Kerski 2003, Baker 2005). In Japan, Fukuda and Tani (2003) mentioned that Japanese schools hardly ever use GIS in class.

Obstacles to introducing GIS into school education are assumed to be the national curriculum standards, the computer and network environments in schools (Minamino 2003), and time constraints because introducing GIS requires a great deal of time to install GIS on the computers, input data and teach students computer literacy, map reading skills and the basics of GIS. However, it is thought that GIS will improve the quality of education and support classes, although the possibility is also pointed out that teachers and students may be burdened by introducing GIS (Yuda and Itoh 2007).

1.3.2 Research on map reading skills

Some studies have dealt with students' map drawing skills and development stages. Iwado and Sashima (1977) wrote about objects and drawing styles by age based on hand-drawn maps in elementary school. Ninohira (1977) showed the differences in level of expression of space with symbols on maps drawn by students from the 1st to the 7th grade. Teramoto (1994) explained how children's cognitive space broadens according to their stage of development using hand-drawn maps by children. Shinohara (1993) researched the map literacy of university students using topographic maps and their map education in primary and secondary education.

Map reading skills can be considered from the point of view of spatial cognition. Studies in the field have already been accumulated and there are many notable theories to explain spatial cognition (Golledge 1978, Evance 1980, Siegel and Schadler 1977). Wakabayashi (1999) said that clarifying the processes by which humans recognize space will “be useful knowledge for improving geography education and the development of GIS.”

1.3.3 Research on the development and practice of GIS in education

Research on introducing GIS into the education field has mainly focused on the effectiveness of GIS in class through practical exercises. These studies have been observed since the 1990s.

To introduce GIS in the education field in Japan, Akimoto (1996) explained about GIS and discussed the problems of introducing GIS into upper secondary schools. Itoh et al. (1998a) and Itoh (1999) explained trends and examples in the United States and mentioned the possibilities of introducing GIS into school education. As for the possibilities of introducing GIS into classes, Ozeki and Hayakawa (2003) considered GIS the ideal support for the chorographical method. Fukuda and Tani (2003) conducted an inquiry survey targeted at teachers and discussed how GIS can be utilized in geography education in upper secondary schools. Itoh and Ugawa (2001) examined the possibilities of using GIS in environmental education through practical use of GIS.

Regarding software, Kobayashi (2001) developed GIS using Microsoft

Excel and Tani developed free GIS software MANDARA and practiced it in classes with teachers in secondary schools (Tani et al. 2002).

Some case studies on fieldwork using GIS have been conducted. Ugawa and Itoh (2002) and Yang et al. (2001) reported on environmental studies using WebGIS. Sugimori (2004) combined digital image data with GPS, and then put the processed data on a map. And Mizutani et al. (2007) used a PDA-sized GIS terminal 'ArcPad' developed by ESRI.

Itoh et al. (1998b) and Okunuki et al. (2000) provided the model for the research and previous studies using Mobile PC GIS or PDA GIS.

1.3.4 GIS and education in foreign countries

In Japan, some researches about education using GIS in foreign countries have been introduced. A few examples such as the United States by Itoh et al. (1998a) and Itoh (1999) and Taiwan by Ida (2004) have been introduced. Geography education in other countries has been introduced, such as education in the United States (Nakayama 1986, Minamino and Fujii 1992), England (Ueno 1994), New Zealand (Ida 1995), Sweden (Murayama 1996), Germany (Mizuoka 1981) and so on, but they do not mention GIS.

With regard to Finnish education, there are studies on teachers' opinions of GIS (Johansson 2003) and practice in using GIS (Johansson and Pellikka 2005, Johansson 2006). However, there are no comparative studies about education using GIS with any other countries. It is the same in Japan. In Japan, Finnish education has attracted a lot of attention in recent years because it boasts the highest academic achievement in the world.

Nevertheless, no specialized study on geography education in that country has been published yet.

References

Akimoto, H. 1996. GIS (chiri joho shisutemu) to koko chiri kyoiku (GIS [Geographic Information System] and geography education in high school). *Shin chiri (New Geography)*, 44-3, 24-32.

Baker, Thomas R. 2005. Internet–based GIS mapping in support of K–12 education. *Professional Geographer*, 57-1, 44-50.

Baker, T. R. and White, S. H. 2003. The Effects of G.I.S. on Students' Attitudes, Self-efficacy, and Achievement in Middle School Science Classrooms. *Journal of Geography*, 102, 243-254.

Bednarz, S. W. 2004. Geographic information systems: A tool to support geography and environmental education? *GeoJournal*, 60, 191-199.

Chiri joho shisutemu (GIS) kankei shocho renraku kaigi (Conference of ministries and agencies concerned with GIS) 2003 "Kokudo kukan deta kiban no seibi oyobi GIS no fukyu sokushin ni kansuru choki keikaku" rebyu (Review of "Strategic plan to improve the national spatial data infrastructure and promote the spread of GIS"), http://www.cas.go.jp/jp/seisaku/gis/h14review.html (Last access: Nov. 13. 2008)

Evance, G. 1980. Environmental cognition. *Psychological Bulletin*, 88, 259-287.

Fukuda,Y.and Tani, K. 2003. Koko chiri kyoiku ni okeru GIS riyo no kanosei (Possibilities of using GIS in upper secondary school geography education). *Saitama chiri (Saitama Geography)*, 27, 17-25.

Golledge, R. G. 1978. Learning about urban environments, In *Making sense of time*, Carlstein, T., Parkes, Don and Thrift, N. eds.76-98.

Ida, Y. 1995. Nyujirando ni okeru chiri kyoiku – sono ninki no yoin – (Geography education in New Zealand: the popularity factors). *Shin chiri (New Geography)*, 43-1, 1-13.

Ida, Y. 2004. Gakko kyoiku ni okeru GIS ni yoru gakushu no ichizuke to kadai – Taiwan tono hikaku ni yoru kyoiku katei no shiten kara – (Evaluation and issues on studies with GIS in school education: from the perspective of curriculum by comparative study with Taiwan). *Tsukuba kyoikugaku kenkyu (Tsukuba Journal of Education Study)*, 2, 103-119.

Itoh, S. 1999. Amerika gasshukoku no gakko kyoiku ni okeru GIS riyo no tenkai (Development of use of GIS in school education in the United States of America). *Chiri joho shisutemu gakkai koen ronbun shu (GISA Conference Papers and Proceedings Collection)*, 8, 1-6.

Itoh, S., Ida, Y., and Nakamura, Y. 1998a. Gakko kyoiku ni okeru GIS riyo-amerika gasshukoku no doko to waga kuni no kanosei (Use of GIS in school education: trends in the United States of America and possibility in Japan). *Chiri joho shisutemu gakkai koen ronbun shu (GISA Conference Papers and Proceedings Collection)*, 6-2, 65-70.

Itoh, S., Okabe, A. Okunuki, K., Shinoaki, S. Akita, Y. Kotsubo, H., Okita, Y., Goto, H., Kaneko, T. Adachi, T. and Balsley, E. 1998b. Toshi keikaku kiso chosa ni okeru mobairu GIS riyo no kokoromi (sono 1) (A trial to use Mobile GIS for urban planning basic survey [part 1]). *Chiri* *joho shisutemu gakkai koen ronbun shu (GISA Conference Papers and Proceedings Collection)*, 7, 137-140.

Itoh, S. and Ugawa, Y. 2001. Kankyo Kyoiku ni okeru GIS Riyo no Kanosei (Possibilities of GIS in Environmental Studies). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 10, 249-254.

Iwado, S. and Sashima, M. 1977. Shogakko ni okeru kukan ninshiki no hattatsu ni kansuru kenkyu -supesu no kotonaru chizu hyogen no baai (Study on development of spatial cognition in elementary school: in case of expressions of maps with different space). *Chizu (Map)*, 15-2, 23-32.

Johansson, T., 2003. GIS in teacher education facilitating GIS applications in secondary school geography. In *ScanGIS'2003 - Proceedings of the 9th Scandinavian Research Conference on Geographical Information Science, 4-6 June 2003, Espoo, Finland*, ed. Virrantaus, K. and Tveite, H., Department of Surveying, Helsinki University of Technology, 285-293.

Johansson, T. ed. 2006. *Geographical Information Systems Applications for Schools – GISAS*. University of Helsinki.

Johansson, T. and Pellikka, P. 2005. Interactive Geographical Information Systems (GIS) application for European upper secondary schools. In *Recent Research Developments in Learning Technologies, III International Conference on multimedia & ICTs in Education*. 505-509.

Kerski, J.J. 2001. A national assessment of GIS in American high schools.

International Research in Geographical and Environmental Education, 10-1, 72-84.

Kerski, J. J. 2003. The implementation and effectiveness of Geographic Information Systems technology and methods in secondary education. *Journal of Geography*, 102: 128-137.

Kobayashi, T. 2001. Excel wo riyo shita chiri joho no riyo ho (Usage of geographic information with Excel). In *Jugyo no tame no chiri joho —shashin, chizu, intanetto— (Geographic information for classes: images, maps and the Internet)*. ed. Ida, Y., Itoh, S., Murayama, Y., Kokon shoin, 146-155.

Kohsaka, H. and Sekine, T. 2003. Chiri joho shisutemu wo riyo shita chiri kyoiku (Geography education using Geographic Information System). In *Chiri kyoiku ni okeru GIS no katsuyo ni kansuru kenkyu (Studies on utilization of GIS in geography education)*. 75-83.

MacEachren, A. M. 2000. Cartography and GIS: facilitating collaboration. *Progress in Human Geography*, 24, 445–456.

Ministry of Education, Culture, Sports, Science and Technology 1998a. *Chugakko gakushu shido yoryo (National Curriculum Standards for Lower Secondary School)*. Tokyo: MEXT.

Ministry of Education, Culture, Sports, Science and Technology 1998b. *Shogakko gakushu shido yoryo (National Curriculum Standards for Elementary School)*. Tokyo: MEXT.

Ministry of Education, Culture, Sports, Science and Technology 1999. *Koto gakko gakushu shido yoryo (National Curriculum Standards for Upper*

Secondary School). Tokyo: MEXT.

Minamino, T. 2003. Waga kuni no gakko kyoiku ni okeru GIS katsuyo no genjo to kadai (Current conditions and issues of utilization of GIS in school education in Japan). *Chiri kagaku (Geographical Sciences)*, 58, 268-281.

Minamino, T and Fujii, Y. 1992. Gasshukoku chiri kyoiku gaidorain ni miru chirigakuteki mikata, kangaekata – gaidorain ni shimesareta shoto kyoiku ni okeru totatsu mokuhyo no bunseki wo toshite – (Geographical view and way of thinking in guidelines for geographic education: through analysis of the achievements in elementary education shown in the guidelines). *Shin chiri (New Geography)*, 40-2, 49-58.

Mizuoka, F. 1981. Doitsu renpo kyowakoku no chiri kyoiku kaikaku (The reform of geography education in the federal republic of Germany). *Chirigaku hyoron (Geographical Review of Japan)*, 54-4, 177-195.

Mizutani, C., Murayama, Y., Morimoto, T., Saito, T. and Kameyama, S. 2007. Firudowaku wo shutai to shita kokosei muke GIS kyoiku- koko, daigaku, kenkyujo, GIS kigyo tono koraboreshon (Education for GIS for high school students based on fieldwork: collaboration of high school, university, research institute and GIS vendor), *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 16, 257-260.

Murayama, A. 1996. Suweden ni miru chiri kyoiku no kozo to rinen – atarashii kyoka chiri wa nani wo mezasu noka – (Structure and philosophy of geography education in Sweden: what is the aim of new geography as a subject?). *Shin chiri (New Geography)*,44-1, 1-13.

Nakayama, S. 1986. Amerika gasshukoku ni okeru chiri kyoiku naiyo no kaizen ni kansuru doko – 1960-85 nen (Trends in improvement of education content of geography in the United States of America in 1960-85). *Hiroshima daigaku kyoiku gakubu kiyo (Bulletin of the Faculty of Education, Hiroshima University)*, 35-2, 59-69.

Ninohira, A. 1977. Byosharyoku no hattatsu to sono keihatsu (Development and cultivation of depiction skills). *Shin chiri (New Geography),* 25-2, 40-56.

Ozeki, Y. and Hayakawa, S. 2003. Chiikisei wo tsuikyu suru GIS kyoiku no kanosei (Possibilities of GIS education seeking regional characteristics). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association),* 12, 255-288.

Okunuki, K., Itoh, S., Okabe, A., Kaneko, T., Goto, H., Shinoaki, S., Tatematsu, T. and Shiozaki, T. 2000. Yagai chosa jisshu no tameno keitaigata GIS no kaihatsu- daigaku no chiri kyoiku ni okeru katsuyo jirei (Development of mobile GIS for field surveys: case study of utilization in geography education in university). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association),* 9, 263-268.

Shinohara, S. 1993. Daigakusei no dokuzu noryoku kara mita chizu kyoiku no mondaiten (Problems of map education from the point of view of university students' map reading abilities). *Kagawa daigaku kyoiku jissen kenkyu (Bulletin of Educational Research and Training of Kagawa*

University), 20, 85-102.

Siegel, A. W. and Schadler, M. 1977. Young children’s cognitive maps of their classrooms. *Child Development*, 48, 388-394.

Sugimori, H. 2004. Yagai jisshu ni okeru keitaigata chiri joho shushu tsuru no tekiyo (Applying a mobile tool for collecting geographic information in outdoor survey). In *Kyoiku GIS no riron to jissen (Theories and practices of education for GIS)*, ed.Murayama, Y., Kokon Shoin, 62-65.

Sugumaran, R., Meyer, J. C., and Davis, J. 2004. A Web-based environmental decision support system (WEDSS) for environmental planning and watershed management. *Journal of Geographical System*, 6, 307–322.

Tani, K., Sato, T., Onishi, K., Okamoto, K. and Okunuki, K. 2002. Chugakko ni okeru chiri kyoiku. GIS no kaihatsu to kyoiku jissen (Development and practice of GIS for geography education in. lower secondary schools).*GIS : riron to oyo (Theory and Applications of GIS)*, 10, 69-78.

Tatsuoka, Y. 2002. “Mijika na chiiki” gakushu ni okeru GIS riyo: jidohanbaiki chosa wo rei to shite(Applying GIS to "local area" study in social studies : a case of studing location of vending machines). *Naruto kyoiku daigaku gakko kyoiku jissen senta kiyo (Bulletin of Research Center for School Education, Naruto University of Education)*, 17, 85-94.

Teramoto K. 1994 *Kodomo no chikaku kankyo: asobi, chizu, genfukei wo meguru kenkyu (Children’s perceptual environment: study on playing, maps and primal scenes)*. Chijin shobo.

Ueno, K. 1994. Igirisu no “Nashonaru karikyuramu ni okeru chiri” seiritsu ni miru chiri kyoiku kaikaku - igirisu chiri kyoiku no rekishiteki kosatsu wo tsujite - (The reform of geographical education in England caused by the establishment of *geography in the national curriculum* [England]: through the historic consideration of geographical education in England). *Shin chiri (New Geography)*, 41-4, 1-13.

Ugawa, Y. and Itoh S. 2002. Kurikkaburu mappu to denshi keijiban wo mochiita kankyo gakushu chizu saba no kaihatsu (Development of environmental study map server using clickable maps and electronic bulletin board). *Chiri Joho Shisutemu Gakkai Koen Ronbunshu (Papers and Proceedings of the Geographic Information Systems Association),* 11, 225-230.

Wakabayashi, Y. 1999. *Ninchi chizu no kukan bunseki (Spatial analysis of cognitive maps)*. Chijin shobo.

West, B. 2003. Student Attitudes and the Impact of GIS on Thinking Skills and Motivation. *Journal of Geography,* 102, 267-274.

Yan, W., Sato, N. Sakaki, D., Koyama, T. 2001. Kankyo kyoiku no tame no WebGIS kankyo no kochiku (Building of the environment of WebGIS for environmental education). *Journal of the Center for Information Studies*, 2, http://www.yc.musashi-tech.ac.jp/~cisj/02/2-6.pdf (Last access: Jan. 8. 2009)

Yuda, M. and Itoh, S. 2007. Possibilities to Utilize GIS in ESD – from Research on GIS for Secondary School Teachers in Japan. *Geographiedidaktische Forschungen*, 42, 109-114.

Chapter 2. School education and GIS in Japan

2.1 Research purpose and methods

2.1.1 Previous researches and purpose of the study

Introducing GIS into the education field, especially into primary and secondary education, has been discussed all over the world for more than a decade. Many scholars believe that GIS will contribute to quality in education because GIS has the educational effectiveness (Bednarz 2004) of developing students' spatial cognition and helping their decision making processes (MacEachren 2000, Sugumaran et al. 2004) as well as increasing students' motivation to learn (West 2003). Also, Ida (2003) says that the functions of GIS can be applied to education, because GIS can be used to edit, analyze and understand data corrected by field work or from the Internet. Itoh and Ugawa (2001) also say that GIS can be applied to environmental education from the same perspective. Furthermore, many experiments show the effectiveness of GIS in education (Tinker 1992, Baker and White 2003, Kerski 2003, Johansson 2006, Kobayashi 2001, Tani et al. 2002, Tatsuoka 2002).

At the same time, the fact that use of GIS has failed to become established in schools has often been reported (Kerski 2003, Baker 2005). How many schools have actually introduced GIS? For example, even in the United States, where GIS has been positively accepted, less than 1% of upper secondary schools have actually introduced GIS (Kerski 2001). In Japan, according to research by Fukuda and Tani (2003), only 1 out of 72 upper secondary schools in Saitama prefecture had used GIS in lessons.

As expectations of GIS use have been raised in various situations, the government of Japan has promoted the development of a National Spatial Data Infrastructure since 1995. GIS was also included in the “e-Japan strategy” that was formulated in 2002, in which ministries and agencies cooperate to provide map data or spatial data free through the Internet [1)].

At the private sector level, many kinds of GIS such as map services like Google Maps and free or inexpensive GIS applications have been provided through the Internet.

Furthermore, the “e-Japan strategy” says, “ ‘Digitization of education’ in the Millennium Project should be accomplished earlier than originally scheduled to facilitate Internet access from elementary, junior and senior high schools and enable IT-driven education.” (The Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society 2002) Since then, the computer and network environment in primary and secondary education has improved dramatically (Figure 2-1).

We can say that nowadays the environment for using GIS is improving. It seems, however, that even though the environment for using GIS in schools is ready, GIS is still not being used in class. What are the obstacles hindering the introduction of GIS into school education?

This chapter aims to consider the school environment into which GIS can be introduced. For this purpose, the author identifies obstacles to the introduction of GIS in school education by a questionnaire survey to teachers and examines the actual situation of GIS in school education in Japan from the viewpoint of the educational curriculum.

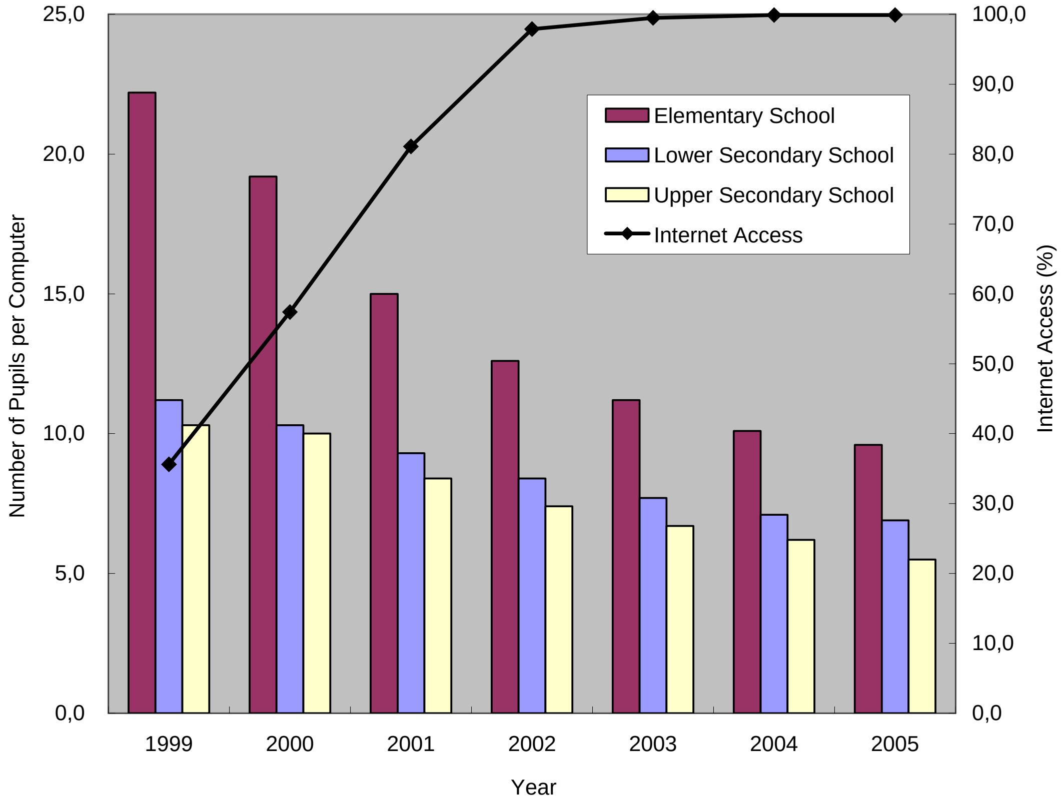


Figure 2-1 Number of pupils per computer and Internet access in elementary and secondary schools in Japan

Source: MEXT (2005)

2.1.2 Research method

To clarify the actual status and background of GIS in school education in Japan based on teachers' opinions, the author conducted a survey of upper secondary school teachers by questionnaire on the use of GIS in class.

The author conducted an inquiry survey of geography teachers in upper secondary schools in the Hokuriku district. The contents of the survey included the teacher's major, subjects and grades taught, use of GIS and opinions on GIS (Appendix 2-1).

2.2 Research on use of GIS in upper secondary schools in Japan

2.2.1 Characteristics of geography teachers and use of GIS

The survey was conducted from December 2006 to January 2007 and the questionnaire was distributed to all 156 upper secondary schools in 3 prefectures (Toyama, Ishikawa and Fukui) in the Hokuriku district. This region was selected because it is regarded as a typical local area, with about 3 million inhabitants [2)], is comparatively independent from metropolitan areas such as Tokyo or Osaka, and each prefecture has developed from its prefectural capital, because the Hokuriku district has no particular city or area where many functions or population are concentrated. Therefore, it was possible to collect a less biased sample.

The percentage of replies was 34.6 percent (54 persons). 85.2 percent of respondents were male (46) and 14.8 percent were female (8). Their average age was 42.9, with teachers in their 30s and 40s predominant (Figure2-2). Respondents in their 20s are few because of the effects of negative recruitment of teachers in recent years.

The work experience of the teachers is similar to the tendency of the teachers' age structure and shows a high proportion of teachers with over 30 years' experience (Figure 2-3).

Half of the teachers surveyed (48.1 percent, 26) teach only geography, while 44.4 percent of the teachers (24) teach geography and other subjects. In other words, 92.6 percent of respondents teach geography classes (Table2-1). All of the teachers who teach more than 2 subjects including geography also teach history. This is because the teaching certificate for geography teachers is issued as a teaching qualification in geography and history and teachers who hold this license can teach both subjects in Japan. Other subjects taught include informational studies, civil engineering and so on.

2.2.2 Teachers' knowledge and experience in use of GIS

Of the respondents, 42.6 percent (23) answered that they are already familiar with GIS (Table 2-2). They studied GIS by themselves or through in-service training courses on GIS. Few of the teachers (9.3%) had studied GIS in university (Table 2-3).

Of the teachers surveyed, 25.9 percent (14) have used GIS (Table 2-4). One quarter of those surveyed understand GIS and have used this tool. However, only 16.7 percent (9) use GIS personally, and, surprisingly, only a few teachers have used GIS in class (5.6 percent, 3, Table 2-5). 2 of these respondents used this tool in geography class and one teacher conducted a

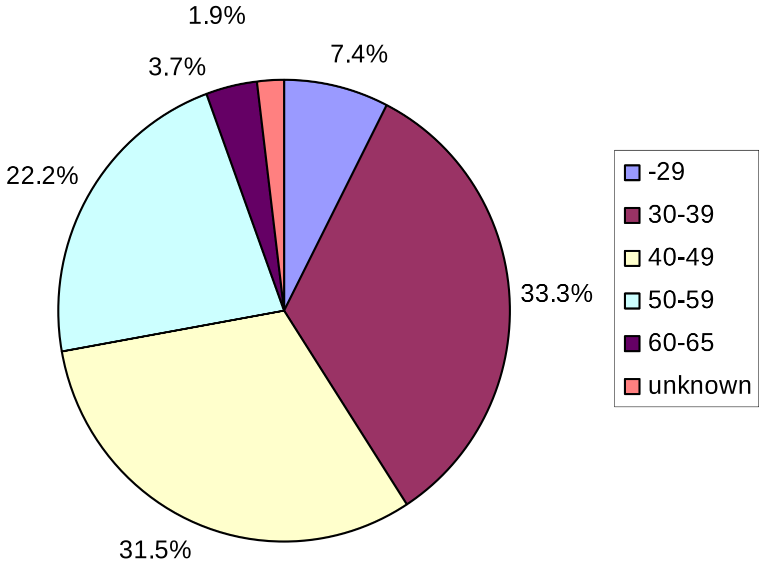


Figure 2-2 Age structure of the respondents

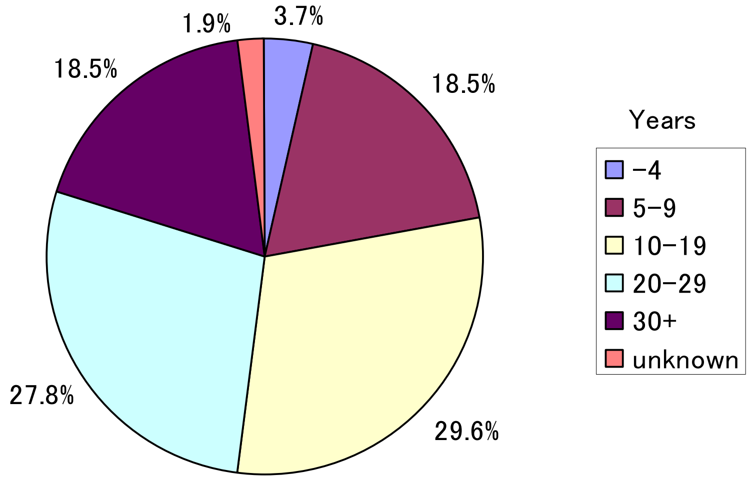


Figure 2-3 Work experience as teachers (years)

Table 2-1 Subjects taught

<table>
<tr><th colspan="3">Subjects</th><th>(%)</th></tr>
<tr><td rowspan="3">Geography</td><td colspan="2"></td><td>48.1</td></tr>
<tr><td rowspan="2">History</td><td></td><td>42.6</td></tr>
<tr><td>Welfare</td><td>1.9</td></tr>
<tr><td colspan="3">History</td><td>1.9</td></tr>
<tr><td colspan="3">Civil Engineering</td><td>1.9</td></tr>
<tr><td colspan="3">Information Studies</td><td>3.7</td></tr>
</table>

(n=54)

Table 2-2 Familiarity with GIS

	(%)
Yes	42.6
No	57.4

(n=54)

Table 2-3 Method of studying GIS

	(%)
Self-learning	43.5
In-service teacher training courses on GIS organized by public organizations such as government entities or universities	39.1
Studied at university	21.7
In-service teacher training courses on GIS organized by private companies	4.3
Others	4.3

(Multiple answers, n=23)

Table 2-4 Previous experience in using GIS

	(%)
Yes	25.9
No	74.1

(n=54)

Table 2-5 Experience in using GIS in class

	(%)
Yes	5.6
No	94.4

(n=54)

Table 2-6 Software used

	(%)
MANDARA*	33.3
KASHMIR 3D*	33.3
Google Earth	16.7
Chizu Taro*	16.7
Digital maps issued by GSI	8.3
ArcGIS	8.3
Super hi map*	8.3
Junior hi map*	8.3

*Original software developed in Japan

(Multiple answers, n=12)

regional survey with GIS in a civil engineering class.

Most of the GIS software that has been used or is currently being used is freeware, which is available on the Internet, such as MANDARA, Kashmir 3D, digital maps issued by the Geographical Survey Institute or Google Earth (Table 2-6). Some OTS software is inexpensive (about 10,000 JPY). Only one teacher used ArcGIS, an expensive GIS software for professionals.

In Japan, some GIS software has been customized for Japan and also digital spatial data is available for free downloads. From this point of view, the environment is favorable for using GIS and teachers can benefit from it.

2.3 Teachers and GIS: the ideal and the reality

2.3.1 GIS from the teachers’ perspective

It was believed that GIS would spread to the field of education through abundant hardware and software. However, the last decade shows that GIS is not used even though the tools and environment around GIS have improved.

As mentioned above, few geography teachers use GIS, but 75.9 percent (41) of respondents answered that GIS is useful to high school geography education (Table 2-7).

Table 2-8 shows teachers’ opinions on GIS. Here the respondents answered that they do not have sufficient skills to operate GIS. More than half of the teachers said that existing desktop GIS or WebGIS does not have functions which are suitable for classes. However, the respondents thought that there were many advantages to be gained by utilizing GIS in class. An often-recurring answer regarding the advantages of using GIS in education was the visualization of data on maps. Also, some teachers pointed out that these maps help pupils to understand the data and phenomena in the study area. Furthermore, some teachers think that such data visualization on maps motivates pupils and increases their interest in geography. Many of the general characteristics of GIS were also mentioned, such as the ability to use fresh data, analyze specific data, deal with multidisciplinary themes, create thematic maps quickly and develop computer literacy. Many teachers think GIS can enhance the problem-solving skills and spatial thinking skills of the students. In addition, 67％ of the respondents pointed out that GIS can be used in cross-disciplinary education.

As mentioned, although few teachers actually use GIS, they are aware of how effective GIS can be in school education. In other words, teachers have a positive recognition of GIS, but they are reluctant to introduce this tool into their classes.

2.3.2 Teachers' view of obstacles to the introduction of GIS into school education in Japan

Problems surrounding the installation of GIS are, in other words, the reason why almost none of the teachers have used GIS in class. 57% (31) of the teachers gave the reasons for why they do not use GIS. The biggest problem they mentioned was that it takes too long for teachers to prepare for lessons. Their thinking is that it is hard to have classes that incorporate GIS. Already they must teach so many things in the curriculum, but teaching hours are limited, and also they have so much to do besides lessons that they have no time to prepare for lessons. Some respondents explained that the education system in Japan, such as the national curriculum and university entrance examination, is a further reason why the GIS system is rarely used. The moment they think of the national curriculum, which has strict guidelines on education, they soon give up any desire to conduct lessons using GIS, even if they are interested in this tool. Also, the respondents said that the computer environment, such as the number of computers or high-performance projectors, is one of the problems. Teachers themselves are also a problem. Pupils' motivation and ability and society's unfamiliarity with GIS were also raised (Table 2-9).

Previously, the most frequent answers as to the reasons for not using GIS were the computer facilities in school, the price of software and datasets and the usability of GIS programs. Indeed, as shown in Figure 2-1, these points have improved dramatically over the last few years. Almost all schools have increased the number of installed computers and introduced broadband Internet connections; therefore, teachers and students can obtain GIS freeware and digital data from the Internet [3)]. From the viewpoint of using GIS, Japanese schools are in a favorable situation for utilizing this tool (Yuda and Itoh 2006). However, it is still true that some teachers say that they cannot use this system because of the computer environment in schools. Hence, we can discern the existence of teachers who have realized that using GIS in education is a matter that largely concerns themselves. They have realized that the problem is the teachers themselves who say that they do not have time to prepare lessons or learn new skills and knowledge.

Table 2-7 GIS is useful in high school geography education

	(%)
Yes	75.9
No	7.4
Don't know	5.6
N.A.	11.1

(n=54)

Table 2-8 Teacher's opinions of GIS (%)

	Fully agree	Moderately agree	Don't know	Moderately disagree	Fully disagree
I can use the basic functions of at least one GIS software in a way that enables me to use GIS as a tool in education.	7.84	17.6	11.8	54.9	7.84
Most common desktop GIS software has an adequate number of functionalities for educational purposes.	7.84	25.5	9.8	7.84	49.0
Most Internet-based GIS software has an adequate number of functionalities for educational purposes.	3.92	27.5	9.8	5.88	52.9
There is plenty of GIS data on the area surrounding our school available on the Internet.	5.88	19.6	7.84	15.7	51.0
Available GIS data from various sources can be used without modification for my own educational purposes.	3.9	11.8	23.5	15.7	45.1
GIS software can be used in education because thematic maps can be created with it.	31.4	39.2	11.8	3.92	13.7
The use of GIS can support inquiry-based learning in lessons.	17.6	41.2	5.9	2.0	33.3
GIS software is often too difficult to use.	5.8	37.3	7.84	19.6	29.4
GIS software can be used in education because regional analyses can be done with it.	23.5	47.1	5.9	7.8	15.7
GIS software can be used in education because our own observations can be visualized with it.	45.1	33.3	1.96	5.88	13.7
GIS software can be used in education because the map objects can be selected and classified with it.	39.2	35.3	5.9	2.0	17.6
The use of GIS in education enhances the problem-solving skills of the students.	17.6	39.2	11.8	5.88	25.5
The use of GIS in education enhances the spatial thinking skills of the students.	37.3	37.3	0.0	3.9	21.6
The use of GIS brings additional value to geography education in schools.	29.4	49.0	3.9	2.0	15.7
GIS can be well used in cross-disciplinary education.	33.3	33.3	3.9	2.0	27.5

(n=51)

Table 2-9 Japanese teachers' opinions of problems in implementing GIS

	(%)
Preparation for lessons	29.0
Lesson hours	19.4
Limitation of computer facilities	16.1
Teachers ability	12.9
Curriculum	6.5
Operation of software	6.5
Coping with less able pupils	3.2
Many school jobs besides lessons	3.2
Students' motivation	3.2
Time required to set up and use PC and teach software	3.2
University entrance exam	3.2

(Multiple answers, n=31)

Teachers are trapped in a vicious cycle; the lesson hours during which they can introduce GIS in class are limited, they have many things to do outside of school hours and not enough time to prepare lessons and study GIS, therefore they do not know how they can utilize GIS in class.

In the matter of time for preparation of lessons or lesson hours, GIS software accounts for part of the problem. To introduce common GIS software in a class, teachers need to prepare the data set. If students are to use GIS to analyze data and examine the results, the teacher needs to teach them how to operate the software and the students need time to input the corrected data by themselves. This means that the teachers have a heavy workload and lesson hours and time outside of lesson hours are put under pressure because of introducing GIS. This is sometimes painful for teachers and students. Because of the work involved in using GIS, there is a risk of not only losing the benefits of GIS, but also missing the aims of lessons and the original purpose of introducing GIS into lessons. Therefore, although the teachers would like to try to use this tool, they cannot afford to conduct classes with GIS.

Also, from the viewpoint of the education curriculum, the teachers commented that they cannot find a linkage between the national curriculum standards and GIS, they think that GIS is unnecessary for the university entrance examination, or they have no time because there is already so much to teach in the curriculum.

In summary, the points surrounding diffusion of GIS in school education in Japan can be summarized into two aspects: the environment in schools

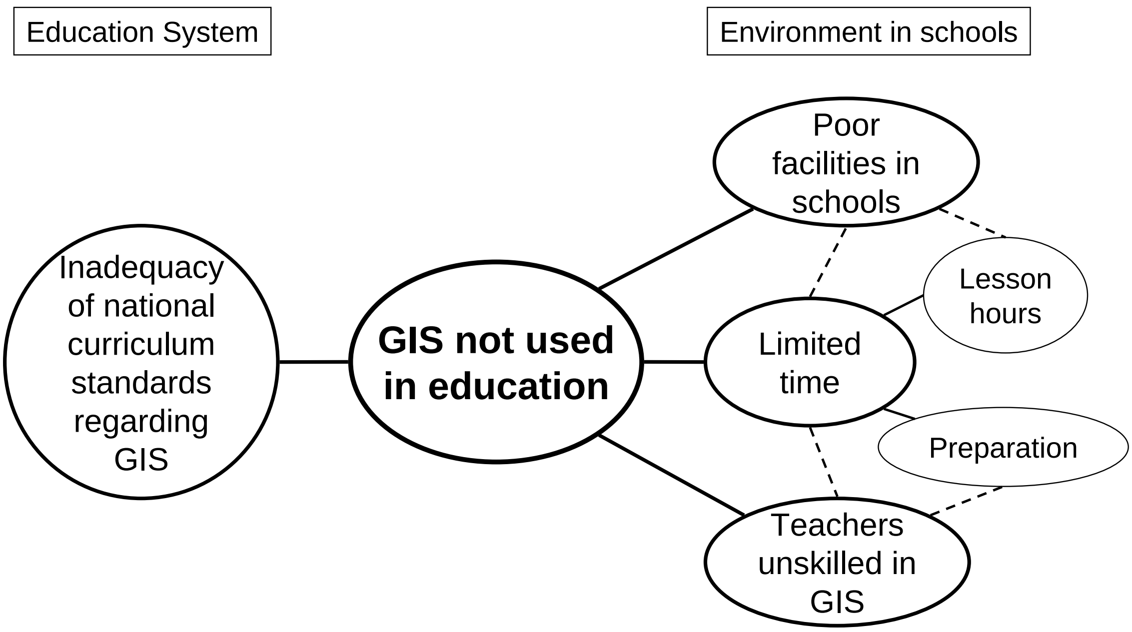


Figure 2-4 Diagram showing current situation of GIS in education in Japan

including the teachers’ situation, lesson hours and facilities, and the education system defined by the national curriculum standards. The difficulties in introducing GIS inherent in each part are as shown in Figure 2-4.

2.4 Japanese educational curriculum and GIS

In the foregoing section, more than half of the respondents are of the opinion that GIS does not have the functions to suit lesson content. Some also say that they cannot find a linkage between GIS and the education curriculum.

These opinions indicate how teachers think of the current education curriculum and GIS. Teachers say that they think GIS does not suit the study content prescribed in the national curriculum standards, they do not know how to use GIS in the curriculum, or they cannot use GIS because there is so much content to be taught in the curriculum. This means that teachers have a passive attitude toward using GIS in class, because they always have in mind the national curriculum standards.

It was thought that improvement of the computer environment in schools, software and information on the system would enable GIS to penetrate the field of education. However, teachers are required to think of lessons within the curriculum defined by the government.

What is the education curriculum in school education? How is the education curriculum decided, and how big is the impact of the curriculum on school education and GIS? In this section, the aim is to examine the reasons for the lack of use of GIS in the education field through understanding of the education curriculum in Japan.

2.4.1 "National curriculum standards" and the education curriculum in Japan

The content of education in Japan is defined in the "Gakushu Shido Yoryo (National Curriculum Standards)". The national curriculum standards are the standards of the education curriculum defined by the government. The Minister of Education, Culture, Sports, Science and Technology makes a public announcement and the Ministry of Education, Culture, Sports, Science and Technology (hereinafter referred to as MEXT) issues a notification through official gazettes. For primary and secondary education, three national curriculum standards have been issued for elementary school and lower and upper secondary schools. The respective curriculum standards explain the aims and content for each grade.

In the first part of each of the national curriculum standards, as a general rule, it states that "each school should formulate harmonious and concrete lesson plans considering the following items with ingenuity and originality" (MEXT 1998a, 1998b, 1999). The national curriculum standards include not only the content of study at each level, but also notices that teachers can refer to when they make their lesson plans. The national curriculum standards indicate the curriculum including the content of education at each school level and points to note when making study plans. However, the national curriculum standards are not the same as the education curriculum. The national curriculum standards set out the standards of the curriculum as the basis of the content of study. Therefore, the curriculum will vary in the different national curriculum standards.

The general rules in the national curriculum standards at each school level state that teachers must organize the education curriculum in accordance with the standards, while at the same time "fostering harmony in the minds of children" and taking into consideration the "actual situation of the school and the local community," the "physical and mental development stages and characteristics" (MEXT 1998a, 1998b), and the "characteristics of the course and subjects" especially in upper secondary schools (MEXT 1999). In addition, the general rules emphasize that "each school" should organize its curriculum. The national curriculum standards specify that the education curriculum in primary and secondary education is formulated based on the curriculum standards and the situation in each school, so every school has its own unique curriculum.

2.4.2 Binding force of the national curriculum standards and organization of the curriculum

In the national curriculum standards, the general rules state that "following the law and the provisions in the chapter below", each school shall "organize an appropriate curriculum" depending on the situation of the school. Here the national curriculum standards declare that all schools must obey the curriculum standards when they organize their curricula. Since when have the national curriculum standards had such a binding force?

The history of the national curriculum standards began with the new education system after World War II. The Ministry of Education issued the "Gakushu Shido Yoryo: Ippan-hen (Shian) (National Curriculum Standards: General [Draft])" in 1947. This draft was critical that "under the prior education system, all schools all over Japan tried to provide the educational content determined by the central (government), even if they had different types of students." After that, the course of study [4] came to be considered in relation to "social demand" and the "lives of pupils and students," and "each school examines and decides the aims of education in consideration of social conditions and pupils and students' lives." Furthermore, the draft defined the characteristics of the national curriculum standards as follows: "This handbook is for teachers to enable them to study how they can apply the new course of study based on the demands of pupils and society." In 1951, the revised national curriculum standards (draft) were issued. The role of the standards as an essential handbook or reference for organizing the curriculum remained the same and it was stated clearly that "in the nature of the national curriculum standards, this book never orders teachers to do anything (Ministry of Education 1952)."

However, the characteristics of the curriculum standards changed drastically in 1958. Before the revision in 1958, "the ministerial ordinance on amending part of the School Education Law enforcement regulations" was in effect. Article 25 of the revised enforcement regulations stated that the "school curriculum should follow the regulations in this section and the national core curriculum, the education standards announced by the Minister of Education." Since then, the national curriculum standards issued by the

Ministry of Education have served as the standards of the curriculum with legally binding power.

The “draft” national curriculum standards in 1947 and 1951 played a role in supporting teachers and lessons, and therefore served as guidelines or a reference for schools to organize their curricula and many ideas or examples of classes were shown in the standards. After 1958, in the national curriculum standards, items to be dealt with and points to consider were itemized without detailed explanation. Then, the national curriculum standards became the standards and discipline to be followed when textbooks, lesson content and curricula in each school were decided (Nagao 1989).

The national curriculum standards are the “standards” for drawing up the curriculum in each school. To organize a proper curriculum, teachers must consider many things such as the “actual situation in the school and the local community” and “physical and mental development stages and characteristics” in the national curriculum standards with originality and ingenuity in their classes. However, teachers are asked to make study plans based on standards that specify that this must be taught but that should not. In other words, it means that teachers try not to touch on anything that is not written in the national curriculum standards.

When teachers read the national curriculum standards, their opinions can generally be divided into two views. One view is that teachers can create lessons freely as far as is defined by the national curriculum standards. The other is they must observe the national curriculum standards, so they do not think to try anything not in the curriculum standards. Teachers who know what GIS is want to use it, but some of them cannot find a linkage between GIS and the national curriculum standards and think that GIS extends beyond the curriculum standards. This is a quite natural attitude, because GIS is nowhere to be found in the national core curriculum.

2.4.3 Problems of the national curriculum standards from the viewpoint of introducing GIS

As described above, the national curriculum standards indicate the objectives in each subject and the items to be dealt with in class. This is the main purpose of the national curriculum standards. Each school organizes appropriate study plans considering these objectives and items in the standards. In the national curriculum standards, what objectives and content of learning in each grade are defined for geography or social studies?

The national curriculum standards for elementary school and lower secondary school consist of “Chapter 1: General rules”, “Chapter 2: Subjects”, “Chapter 3: Moral education” and “Chapter 4: Special activities”. For upper secondary schools, Chapter 2 becomes “Subjects in general education” and Chapter 3 “Subjects in professional education.” The core of the respective curriculum standards is the subjects in Chapter 2 (Chapter 3 for upper secondary schools). Each subject’s objectives, the objectives and study content in each grade, and how to make lesson plans and deal with the contents are explained in each section.

Table 2-10 shows the objectives of subjects including geography in each school. The most noteworthy of the objectives is to “utilize maps and various

Table 2-10 Objectives in geography and related courses in the Japanese National Curriculum Standards

Elementary school		Lower secondary school	Upper secondary school
Life studies	Social studies	Social studies/ Geographic field	Geography and History
[1st・2nd grade] (1) Develop interest in relations between self and people around one, in various places and public property, feel attached to them, think of role of self as a member of a group or society and act appropriately. (2) Develop interest in relations between self and animals and plants, protect nature and devise own games or life. (3) Find enjoyment in activities about society and nature with people around one and express findings or enjoyment in words, pictures, performances or plays, etc.	[3rd・4th grade] (1) Understand the industries in the local community and consumer life or various activities to protect people's healthy lives and safety and raise awareness of self as a member of society. (2) Understand the geographical environment in the local area, changes in people's lives and efforts of ancestors in society and feel pride in and affection for the local community. (3) Observe and research the geographical phenomena in local area, utilize map and various source materials effectively and make a presentation about findings, and consider the characteristics of social phenomena in the local community and their relationship. [5th grade] (1) Understand the industries in Japan and relationship between industry and people's lives, and develop interest in expansion of industry in Japan. (2) Understand natural conditions in Japan and importance of land conservation and feel affection for the national land. (3) Research social phenomena, utilize maps, statistics and various basic source materials effectively and make a presentation about findings, and consider the meaning of social phenomena. [6th grade] (1) Develop interest in and understand deeply our ancestors who contributed to the development of the nation and society in Japan and our excellent cultural heritage, cherish our history and traditions, and foster patriotism. (2) Be able to understand politics in daily life, basic policies, life in other countries closely related to Japan and role of Japan in world society, and realize that it is important that each student, as a Japanese, hopes for peace together with other people in foreign countries. (3) Research social phenomena, utilize maps, chronological tables and various basic source materials effectively and make a presentation about findings, and consider the meaning of social phenomena from a wide point of view.	(1)Develop interest in geographical phenomena in Japan and the world, consider and understand regional characteristics of land in Japan from broad perspective, cultivate basic geographical point of view and way of thinking and foster cognition of land in Japan. (2) Understand phenomena in Japan or the world from relationship with location or spatial distribution, consider them in relation to size of the region, environmental conditions and people's lives and study points of view and ways of thinking to understand regional characteristics. (3) Compare Japan and the world with its various sized regions and understand that each region is connected with each other, characteristics of each region have uniqueness and general commonalities, and these characteristics are changing. (4) Raise students' interest in geographic phenomena through area surveys, foster multi-dimensional thinking and fair judgment of geographic phenomena by appropriate choice and use of source materials and develop abilities and attitudes to express them properly.	(Geography A) Consider various geographical issues in contemporary society in view of regional characteristics, foster geographical cognition in contemporary world. At the same time, cultivate geographical point of view and way of thinking and consciousness and quality as a Japanese living responsibly in the global society. (Geography B) Consider various geographical issues in contemporary society by systematic geography or topography, foster geographical cognition in contemporary world. At the same time, cultivate geographical point of view and way of thinking, and consciousness and quality as a Japanese living responsibly in the global society.

(Source: MEXT 1998a, 1998b, 1999)

source materials effectively and make presentations about findings" and is emphasized in all grades in social studies in elementary school (MEXT 1998b). Also, in the geographical field in social studies, one of the objectives is to "(4) raise students' interest in geographic phenomena through area surveys, foster multi-dimensional thinking and fair judgment of geographic phenomena by appropriate choice and use of source material, and develop the abilities and attitudes to express them properly (MEXT 1998a)." Although the word 'map' does not appear, there are some expressions that can be considered as lessons with maps, because for area surveys maps are essential, and maps are also effective for improving multidimensional thinking.

Furthermore, with regard to handling of the contents, notices have been issued that when pupils in elementary school "collect, use and assemble data or information, they should utilize the school or public library and maps in atlases as textbooks after 4th grade," and "in each grade (teachers and pupils) should utilize maps and statistics effectively and understand the structure of the prefectures in Japan (MEXT 1998b)." In lower secondary school, "(teachers) must teach systematically so that students acquire a geographical point of view and way of thinking as well as skills such as reading and drawing maps and reading landscape photographs. And when (students) collect and process data or information on the area, they should try to make positive use of computers and information and telecommunications networks" and "use large-scale maps, statistics and other materials frequently and improve their skills (MEXT 1998a)." Also, in upper secondary school, "(teachers) must teach systematically so that students acquire a geographical point of view and way of thinking as well as skills such as reading and drawing maps and reading landscape photographs. (Teachers) must introduce practical and hands-on learning such as using globes and maps, collecting, examining, researching and processing geographical data or information, statistics, images and literature, and making maps or geographic information using various data (MEXT 1999)." Here we cannot find the word "GIS", although some expressions on the utilization of computers can be deemed to include utilization of GIS.

However, there is a major problem. Although the national curriculum standards emphasize utilization of maps, map study to learn about maps themselves such as learning the definition of a map or how to read maps is not mentioned. In fact, there are no units for learning the basic skills of map literacy that are necessary for using GIS.

Here the binding force of the national curriculum standards must be recalled. The principle is not to touch on anything but the contents dealt with in the national curriculum standards. This principle is well reflected in the contents of textbooks. For example, life studies in 1st and 2nd grade in elementary school is a subject that integrates nature and social studies. In this subject, there is a unit in which pupils explore their neighborhood area and make a presentation on their research. In every life studies textbook for 2nd grade, a large handmade map appears as an example of the presentation. On the pages of the textbook, there are actual maps and many pictures of maps, but the word "map" is rarely found and there is no explanation of the map itself [5)].

All social studies textbooks in 3rd grade in elementary school start from a survey of the neighborhood area, so handmade maps or base maps, compasses, symbols and contours appear on the first few pages. But there is no definition of the map itself. In Japanese education, pupils and students must study map symbols and contours and read information from maps without learning what a map is.

In textbooks for the geography field of social studies in lower secondary school, there are articles about car navigation systems or GPS which are linked to GIS. Only one of the 6 textbooks in the geography field that the author referred to deals with GIS [6)].

These facts indicate the difficulty of incorporating map study or GIS, which cannot be found in the national curriculum standards, in textbooks which are made along the lines of the curriculum standards.

In the national curriculum standards and compliant textbooks there is no mention of map study as the basic skill for using GIS and the word GIS is not used, even though utilization of maps is emphasized and there are some expressions that are deemed to refer to GIS. School education in Japan is not prepared to use GIS in classes. Therefore, teachers understand that GIS is theoretically a useful tool. However, they have no reason to be motivated to use GIS because GIS is neither mentioned in the national curriculum standards nor in textbooks.

2.5 To introduce GIS into school education in Japan: conclusion

In this chapter, the author discusses the situation of GIS in Japanese upper secondary schools and the obstacles to introducing GIS revealed by a questionnaire survey to teachers in the Hokuriku district.

According to the responses, although many teachers understand what GIS is, only a few teachers use it in their classes. There are three major reasons for the lack of use of GIS in classes: time, facilities and the education curriculum. Japanese teachers not only teach their specialized subjects but also do miscellaneous things in school. Some respondents complained that they do not have time to study themselves, because they have too much work to do every day in school. This means that teachers have limited time to prepare and take classes and they do not have time to enhance their skills. Teachers also pointed out that use of the computer, network and software environments is not free. In addition, the education curriculum defined by the national curriculum standards makes introducing GIS difficult.

Regarding these problems of preparation time or lesson hours, development of GIS itself might be able to provide some support. But development of useful GIS is not enough to use it in class, because the national curriculum standards so far mention nothing about GIS. The national curriculum standards strongly influence the education curriculum in each school. There is no unit for the study of map literacy which is not only the foundation of geography but also an essential part of GIS, even though the national curriculum standards mention promotion of utilization of maps in class.

On the contrary, if a curriculum that gave students a firm foundation in map literacy were included in the national curriculum standards, GIS would be accepted in school education. Institutional improvement, however, is not the goal. There are still many obstacles to the introduction of GIS into school education, such as the problem of school facilities or teachers' skills. For GIS to be introduced into school education, we not only need national curriculum standards that include GIS, but also solutions to the problems involved in using GIS in class, such as enhancing teachers' skills and providing the computer and network facilities to enable use of GIS.

Notes

1) The Geographical Survey Institute has its own website "Chizu etsuran sabisu 'Wotchizu' [Map browsing service 'watch-map']" (http://watchizu.gsi.go.jp/) which provides topographic maps on a scale of 2,5000:1 free. Also "Denshi kokudo potaru [Electronic land portal]" (http://portal.cyberjapan.jp/) provides various geographic data free.

2) According to the census figures for 2005, the total population in the Hokuriku district is 3,107,185 inhabitants.

3) In the 2007 academic year, 56.5％ of elementary schools, 59.9％ of lower secondary schools and 85.4％ of upper secondary schools had access to a high-speed and constant network connection (MEXT 2008).

4) Only in the national curriculum standards (draft) in 1947 was the term "course of study" used. Since then, the term "curriculum" has been used.

5) In Amano et al. (2003) the term “kaado echizu (Card picture-map)” is used in the explanation about presentations, but other life studies textbooks do not use the term “chizu (map)” at all.

6) Kaneda et al. (2006)

References

Amano, M., Terao, S., Aibe, Y., Abe, O., Ohno, Y., Kajiwara, Y., Sakado, H., Sawamoto, K., Sugusawa, M., Takemura, S., Takeyama, T., Tanaka, H., Tsukada, Y., Terakawa, T., Terashi, N., Naka, M., Nakano, M., Wakabayashi, T., and Shinko publishing Keirinkan editorial department 2003. *Iki iki seikatsu: Ge (Active life for 2nd grade)*. Keirinkan.

Baker, T. R. 2005. Internet-based GIS mapping in support of K-12 education. *Professional Geographer*, 57-1, 44-50.

Baker, T. R. and White, S. H. 2003. The Effects of G.I.S. on Students' Attitudes, Self-efficacy, and Achievement in Middle School Science Classrooms. *Journal of Geography*, 102, 243-254.

Bednarz, S. W. 2004. Geographic information systems: A tool to support geography and environmental education? *GeoJournal*, 60, 191-199.

Fukuda, Y. and Tani, K. 2003. Koukou chiri kyoiku ni okeru GIS riyou no kanousei (Possibilities of using GIS in upper secondary school‘s geography education). S*aitama chiri (Saitama Geography)*, 27, 17-25.

Ida, Y. 2003. Ningen keisei no kanten karano gakkou kyouiku ni okeru GIS dounyuu no igi (Significance of introducing GIS in school education from the point of view of human development). In *Chiri kyouiku ni* *okeru GIS no katsuyou ni kansuru kenkyuu (Studies on utilization of GIS in geography education)*, ed. Murayama, Y., 11-22.

Itoh, S. and Ugawa, Y. 2001. Kankyou kyouiku ni okeru GIS riyou no kanousei (Possibilities of GIS in Environmental Studies). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 10, 249-254.

Kaneda, A., Ishiguro, M., Konagaya, Y., Takahashi, S., Teramoto, K., Hori,N., Mikami, T., Mizuuchi, T.,Mizuyama, M., Mizoguchi, T., Miyaguchi,T. and Osaka shoseki editorial department 2006. *Chugaku shakai: chirigaku bunya (Social studies: field of geography)*. Osaka shoseki.

Kerski, J.J. 2001. A national assessment of GIS in American high schools. *International Research in Geographical and Environmental Education*. 10-1, 72-84.

Kerski, J. J. 2003. The implementation and effectiveness of Geographic Information Systems technology and methods in secondary education. *Journal of Geography*, 102, 128-137.

Kobayashi, T. 2001. Excel wo riyou shita chiri jouhou no riyou hou (Usage of geographic information with Excel). In *Jugyo no tame no chiri jouhou —shasin, chizu, intaanetto— (Geographic information for classes: images, maps and the Internet)*, ed. Ida, Y., Itoh, S., Murayama, Y., Kokon shoin, 146-155.

MacEachren, A. M. 2000. Cartography and GIS: facilitating collaboration. *Progress in Human Geography*, 24, 445–456.

Ministry of Education, Culture, Sports, Science and Technology 1998a. *Chugakko gakushu shido yoryo (National Curriculum Standard for Lower Secondary School)*. Tokyo: MEXT.

Ministry of Education, Culture, Sports, Science and Technology 1998b. *Shogakko gakushu shido yoryo (National Curriculum Standard for Elementary School)*. Tokyo: MEXT.

Ministry of Education, Culture, Sports, Science and Technology 1999. *Kouto gakko gakushu shido yoryo (National Curriculum Standard for Upper Secondary School)*. Tokyo: MEXT.

Ministry of Education, Culture, Sports, Science and Technology 2008. *Gakkou ni okeru kyoiku no jouhouka no jittai ni kansuru chousa kekka (heisei 19 nendo) (Results of actual situation survey on digitization of education in school [academic year 2007])*. http://www.mext.go.jp/a_menu/shotou/zyouhou/08092209.htm (Last access: 11.13.2008)

Ministry of Education 1952 *Gakushu shido yoryo: Rikahen (Shian)(National Curriculum Standard for Elementary School: Natural Study [Tentative])*. Tokyo: Ministry of Education.

Nagao, A. 1989. *Shin karikyuramu ron (New curriculum theory)*, Yuuhikaku.

Sugumaran, R., Meyer, J. C., and Davis, J. 2004. A Web-based environmental decision support system (WEDSS) for environmental planning and watershed management. *Journal of Geographical System*, 6, 307–322.

Tatsuoka, Y. 2002. "Mijika na chiiki" gakushu ni okeru GIS riyou: jidouhanbaiki chousa wo rei to shite. *Naruto kyoiku daigaku gakkou kyouiku jissen senta kiyo (Bulletin of Research Center for School*

Education, Naruto University of Education), 17, 85-94.

Tani, K., Sato, T., Onishi, K., Okamoto, K. and Okunuki, K. 2002. Chugakkou ni okeru chiri kyouiku. you GIS no kaihatsu to kyouiku Jissen (Development and practice of GIS for geography education in. lower secondary schools).*GIS : riron to ouyou (Theory and Applications of GIS)*, 10, 69-78.

The Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society 2002. *e-Japan Strategy*. http://www.kantei.go.jp/foreign/it/network/0122full_e.html (Last access: Nov. 27. 2008)

Tinker, R. F. 1992. Mapware: Educational applications of Geographic Information Systems, *Journal of Science Education and Technology*, 1, 35-48.

West, B. 2003. Student attitudes and the impact of GIS on thinking skills and motivation. *Journal of Geography,* 102, 267-274.

Yuda, M. and Itoh, S. 2006. Utilization of Geographic Information Systems in education reform in Japan. In *AGILE 2006: Shaping the future of geographic information science in Europe*, 98-103.

Chapter 3. Development of map reading skills and GIS

3.1 Purpose and background of study

In order to develop GIS for school education, it is necessary to understand the users of GIS. The main users in school education are teachers and students. Students have been researched from the viewpoint of spatial perception and development of map skills. Some studies have dealt with students' map drawing skills and development stages. Iwado and Sashima (1977) wrote about objects and drawing styles by age based on hand-drawn maps of the route from home to school by pupils from the 1st to the 6th grade in elementary school. Ninohira (1977) showed the differences in level of expression of space with symbols on maps drawn by students from the 1st to the 7th grade and suggested a teaching method for appropriate development of map skills by the development stage of the students in each grade. Teramoto (1994) explained how children's cognitive space broadens according to their stage of development using hand-drawn maps by children. Shinohara (1993) researched the map literacy of university students using topographic maps and their map education in primary and secondary education.

However, these studies dealt with the level of spatial cognition or understanding of topographical maps. When using GIS, one of the map skills a user needs is the ability to think of an object on the map as the same object in the real world. In other words, what do students look at on maps to enable them to understand maps linked to the actual world?

Wakabayashi (1999) said that clarifying the processes by which humans recognize space will “be useful knowledge for improving geography education and the development of GIS.” The development side needs to clarify the tendencies in students’ map reading in order to be able to develop effective GIS use in education and support users.

The aim of this chapter is to understand user characteristics in map reading. Focusing on how students read maps, the author tries to clarify differences in reference points for reading maps by age and accuracy of map reading. The research was conducted to identify tendencies in how students read maps at each school level from elementary school to university. At elementary school level, the author observed the distribution of points on the map which the pupils were instructed to find along the route of an “expedition” round the school’s neighboring area. In lower and upper secondary schools, the author asked students about their reference points for finding objects on a map. At university level, the author asked students to find certain objects on campus on the map and indicate the reference points used to find these objects. It is expected that these experiments will clarify the differences in ways of reading maps by age and level of map reading skills.

3.2 Map literacy of elementary pupils

3.2.1 Classes using maps in elementary school

The National Curriculum Standards for Elementary School (MEXT 1998) highly recommend outdoor activities as a learning activity to “comprehend the relationship between the pupils themselves and people in the community and society and nature" in life studies. Therefore, "expeditions" around their home areas near school, in short, fieldwork, are included. This fieldwork in life studies emphasizes observation of features in the neighboring area, and pictorial maps often appear in textbooks. However, textbooks never explain what a map is, and even the word, "map [1)]," rarely appears in textbooks.

Social studies classes start from the 3rd grade. In the 3rd and 4th grades, the objective of this subject is to understand the geography of the neighborhood area. The national curriculum standards state that "(teachers make pupils) find differences by location through, for example, describing on a blank base map the area or city (ward, town or village) where they live". Here the word "map" appears in the national curriculum standards from the 3rd grade. This means that maps are introduced in class.

Here we see how pupils in the 3rd grade, who have just been introduced to maps in class, can read maps.

3.2.2 Outline of the research

A survey of 33 elementary school pupils in the 3rd grade was conducted at Oshima Elementary School in Imizu city, Toyama prefecture on 16th May, 2007. The lesson was entitled "Let's go on an expedition around the school" and involved all the 3rd grade pupils following a route around the school neighborhood and marking the buildings near the school on the "expedition map", a blank base map showing only the roads and compass (Figure 3-1). The point of the study was for the pupils to mark the position of each building on the map.

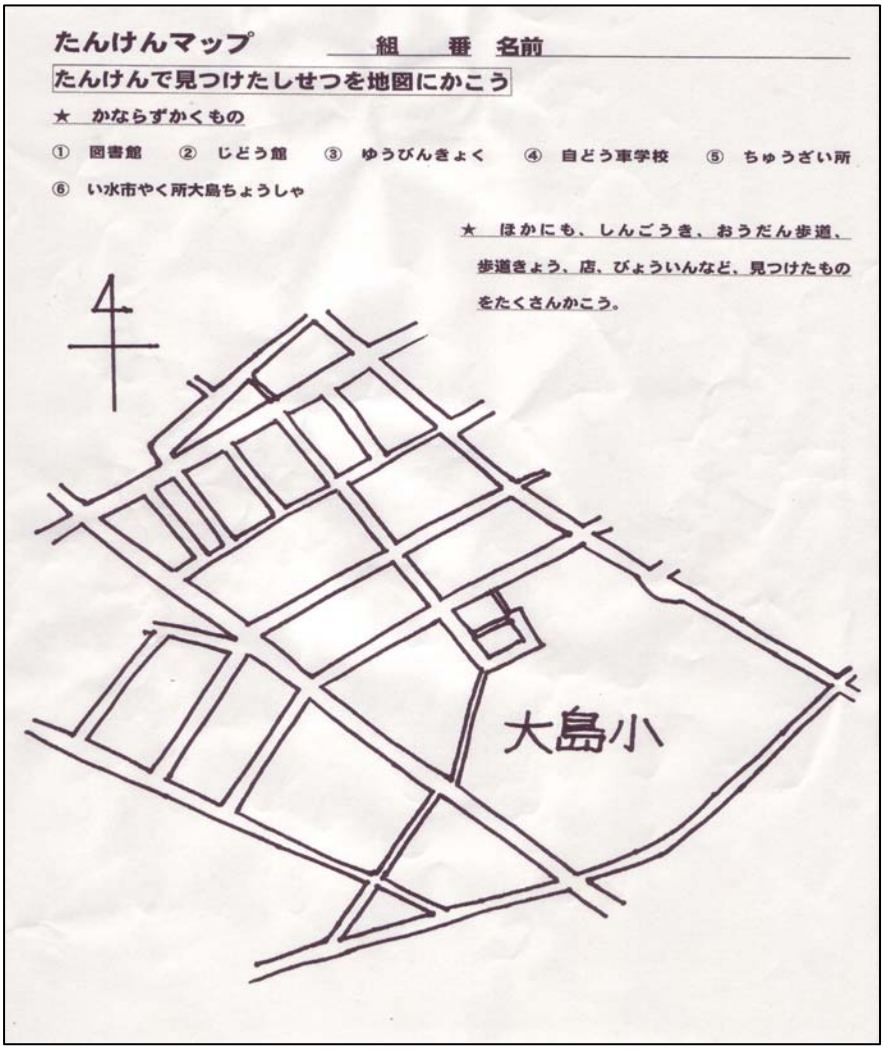


Figure 3-1 Map for exploring the school's neighborhood for 3rd grade pupils in elementary school

3.2.3 Pupils' recognition of objects on the map

The route of the expedition is shown in Figure 3-2. Along the route there are 6 main buildings. Pupils followed the route for about 1 km, spending 45 minutes for the lesson while drawing the position of each building on the map. The 6 buildings are the post office, city hall, library, driving school, children's center and police substation. Here the location of each building drawn by the pupils is compared to its actual position on the map.

1) Post office

The post office is located along the main street in front of the school and on the opposite side to the school. Pupils found it after walking 500m from the school. 60.6％(20) pupils marked it on the map.

The positions where pupils marked the building tended to be distributed on one side of the school (Figure3-3). Before reaching the post office, they turned twice at intersections, so many of them were confused about the direction they were going in, and about left and right, and viewed the map wrongly.

2) City hall

The city hall is located across the main street from the school. It is quite a large building and the second object that the pupils found on their expedition.

More than 70% of the pupils marked this building on the map, because many of them recognized the existence of the city hall, though most of the pupils put the city hall in the wrong position and the plotted positions were dispersed (Figure 3-4).

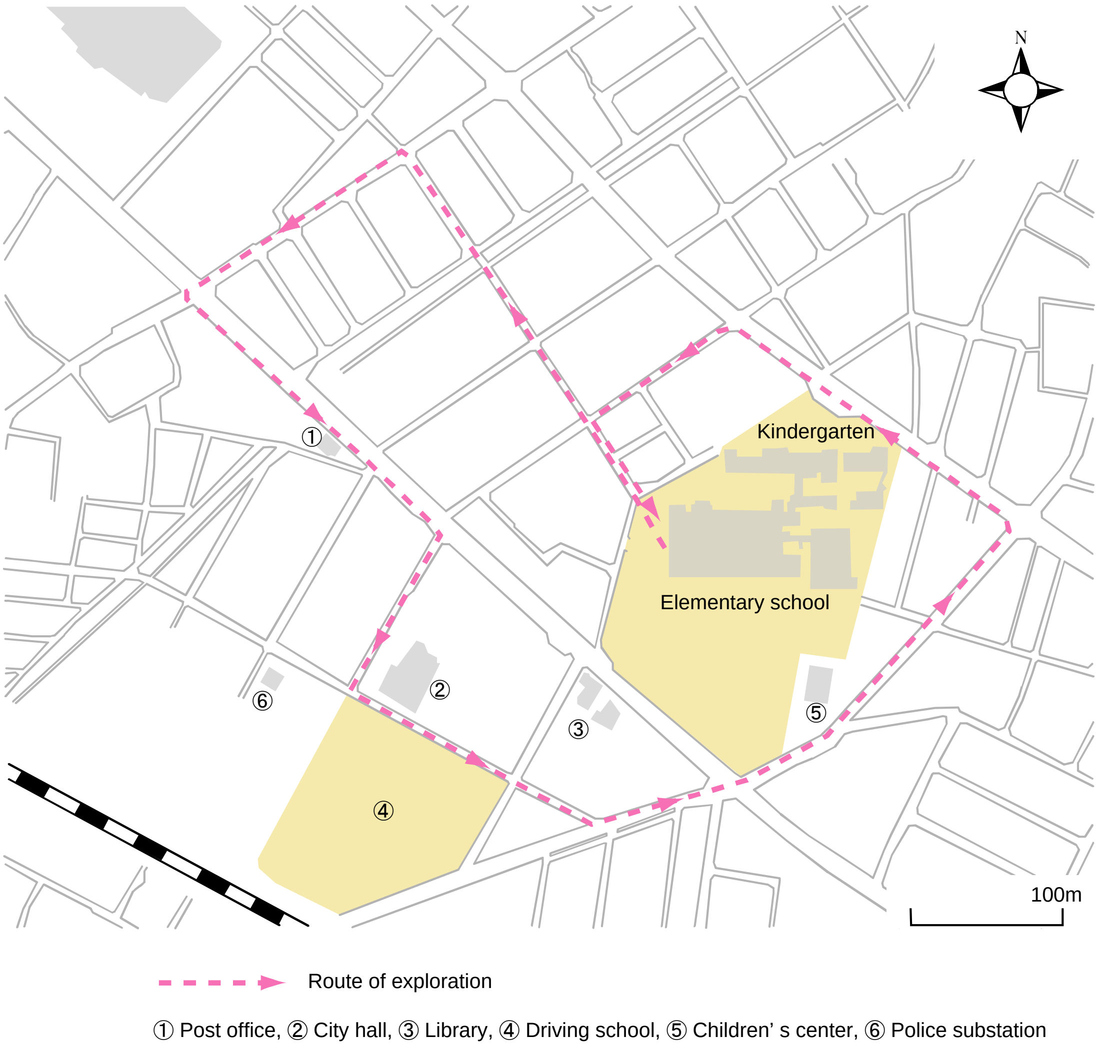


Figure 3-2 Route map for exploring the school's neighborhood and locations of buildings which pupils must seek on the way

Position of post office   Location of post office drawn by pupil on the map

Figure 3-3 Position of post office and distribution of locations of the post office drawn by pupils

When they arrived at the location of the city hall, the pupils had already walked a considerable distance and crossed several streets. Therefore, they were uncertain as to which block the building was located in on the map.

3) Library

The library is across the main street from the school. The building is next to the city hall and the pupils know it well. However, less than half of the pupils (42.4％, 14) indicated the position of the library on the map. Furthermore, none of the pupils positioned it correctly. Not a single pupil even marked it in the right block (Figure3-5).

The reason for this may be that the children could not see the library building from the route, so they could not confirm its position by sight, and most of them had lost themselves on the map after passing the post office and the city hall.

4) Driving school

The landscape of the driving school is unique because of the characteristics of the driving school. The site is large, so pupils found it easy to recognize the existence of this facility. Therefore, about 80% of them marked the position of the driving school on the map.

The positions of the driving school were plotted around the crossing where that school came into sight. Only a few pupils marked the position inside the actual site of the driving school (Figure 3-6).

Many answers on the map were given by pupils who did not understand their position, the exploration route or objects they had already seen including the driving school.

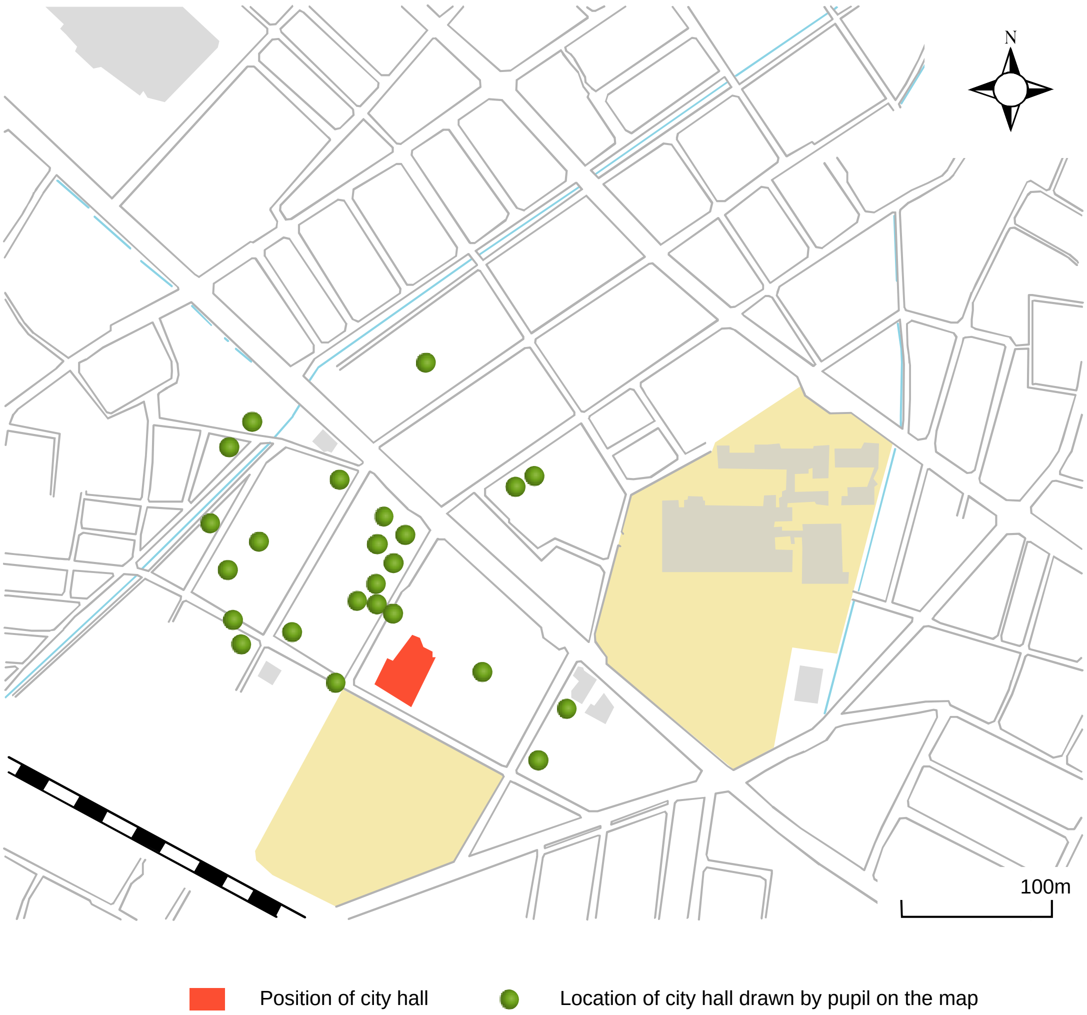


Figure 3-4 Position of city hall and distribution of locations of the city hall drawn by pupils

Position of library
Location of library drawn by pupil on the map

Figure 3-5 Position of library and distribution of locations of the library drawn by pupils

5) Children's center

The children's center is adjacent to the school and many pupils visit it daily. Accordingly, 93.9% (31) of pupils marked the location of the building on the map, many of them fairly accurately (Figure 3-7). Even though they plotted other landmarks wrongly, their cognitive distortion was corrected when they found the children's center.

Although the children seemed to find the road facing the children's center, their answers were distributed in the areas around two intersections. Probably, some of pupils knew that the children's center was next to the school and near the crossing, but they still seemed to be confused about what they saw in the real world and what they saw on the map. Even with a well-known object, they still seemed to find it difficult to match their cognition with the actual position on the map.

6) Police substation

Only two pupils marked the position of the police substation on the map. And the points which they plotted were totally wrong (Figure 3-8).

There are two 'unknowns' that are possible reasons why the pupils could not mark the position. First, the police substation was not located along the route of the expedition and the pupils really might not have known where it was, and they may not have known what 'police substation (Chuzaisho)' meant because they had not learnt the word yet. For 3rd grade pupils it must be hard to mark something which they cannot actually see on a blank base map with no information but the outline of the roads.

Figure 3-6 Position of driving school and distribution of locations of the driving school drawn by pupils

Figure 3-7 Position of children’s center and distribution of locations of the children’s center drawn by pupils.

7) Kindergarten

The pupils were given some instructions concerning the blank map that was distributed to them. Apart from instructions on marking certain specified objects on the map, pupils were directed to "mark as many things as you can on the map." So the children freely marked things that they noticed. In particular, 66.7% of pupils (22) marked the kindergarten, and most of them plotted the location with considerable accuracy on the map (Figure3-9).

In front of the kindergarten, there is a driveway. Many pupils marked this uniquely shaped road as the kindergarten on the map. Many of the pupils attended this kindergarten before coming to the elementary school, so it was very familiar to them. When they came to the kindergarten in the morning and went home in the afternoon, they would get in and out of the car or bus on this driveway. For some children, the kindergarten might be associated with arriving at this place rather than the actual kindergarten building. Therefore, it is assumed that many pupils marked the road near the kindergarten.

From the distribution tendency seen in the plotting, the pupils seemed to find it hard to think of direction in the real world and on the map as the same thing. About half of the pupils plotted the position of the kindergarten on the opposite side of the road from its actual location.

3.2.4 Landmarks for pupils in elementary school

In the class, a blank map showing only the roads, the compass and the school name at the position of the school was used. The map provided

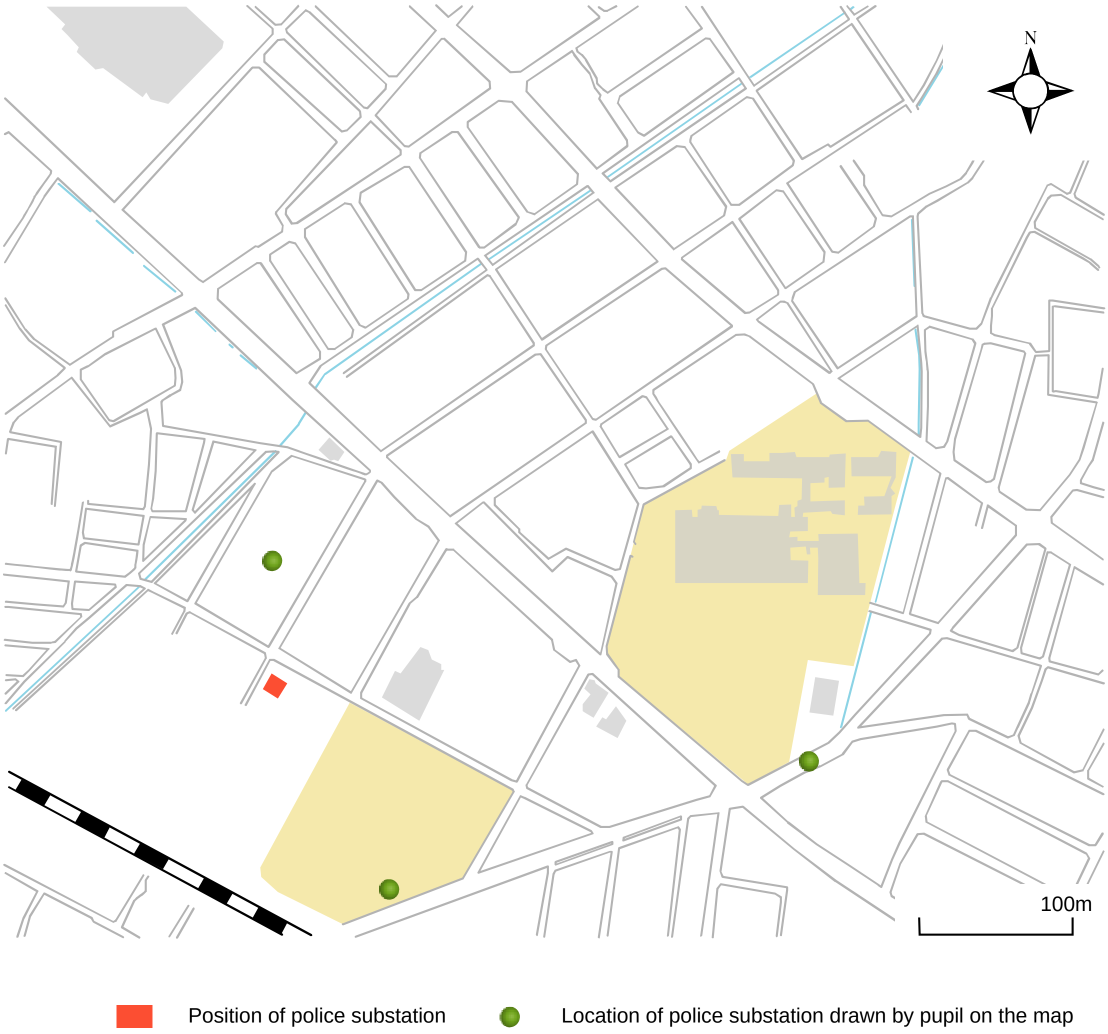


Figure 3-8 Position of police substation and distribution of locations of the police substation drawn by pupils

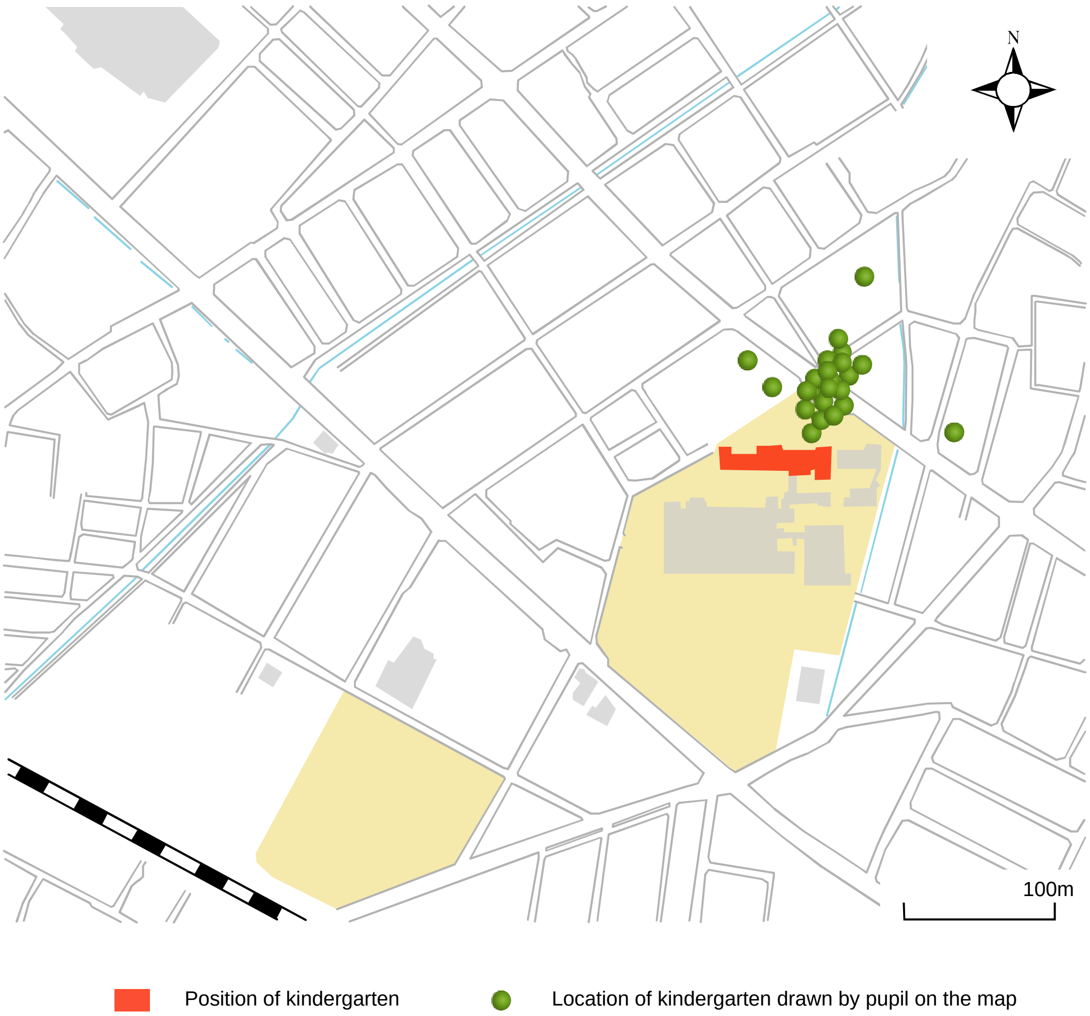


Figure 3-9 Position of kindergarten and distribution of locations of the kindergarten drawn by pupils

minimal information. Furthermore, the objects that the pupils were asked to mark on the map were landmarks that teachers (adults) considered as such.

The number of pupils who plotted the positions varied for each object. Of course, there were buildings that many pupils plotted (irrespective of how accurate their answers were), while on the other hand, there were objects that most pupils did not mark at all. In addition, as mentioned above, pupils were permitted to freely mark whatever they found. Figure 3-10 shows the objects that they marked on the map. According to the data, the objects they noted were related to transportation such as a zebra crossing and pedestrian bridge, shops such as the supermarket, restaurant and dry-cleaning shop which they had visited with their families, and the hospital. Some pupils plotted their friend’s houses or the places they went to for piano or calligraphy lessons.

The world of pupils around age 8-9 is limited to their route from home to school, the location of their friends’ homes and playgrounds where they play with their friends, and the pattern of activities of other family members. This tendency coincides with Golledge’s skeletal node-path relations, where paths that connect the home, school and other key places as nodes become key elements in developing an understanding of the environment around them (Golledge 1978). Teramoto (1994) said that the area a child knows well widens from the route connecting home and school to the outside and they become able to depict features along the route. Their special cognition is not surface, but linear along the route from home to school. Some of the buildings dealt with in the survey might be located away from pupils’ commuting routes, so they would not know these objects.

3.2.5 Maps from elementary school pupils' point of view

The pupils did not get lost on the expedition and were able to come back to school safely. Although they knew where they had walked, they did not know where they were 'on the map.' In other words, they were always 'lost' on the map during the expedition.

On the map used in this class, there were no elements to help the pupils to define the place where they were on the map, except the shape of the roads and the location of the school. Originally, the spatial cognition of children at age 8 or 9 is still developing and they do not yet recognize features very well. From this point of view, the results of the survey mean that this map without landmarks or objects to refer to did not work as a map for the 3rd grade pupils.

The eye level of pupils in the 3rd grade is normally low, so it would be hard for them to imagine how wide the road is or how big the driving school is or how they are shaped from above. They could not grasp that the road drawn on the map represented the road that they could see with their own eyes. Furthermore, they had no sense of distance or map scale. They were always confused, because they could not imagine that what was drawn on the map was the same as what they could see.

However, there were some buildings, notably the children's center and the kindergarten, which the pupils plotted on the map fairly accurately. These buildings are located next to the school. The elementary school was only specified on the map by letters. This information on the location of the school was the most important and recognizable factor for the pupils.

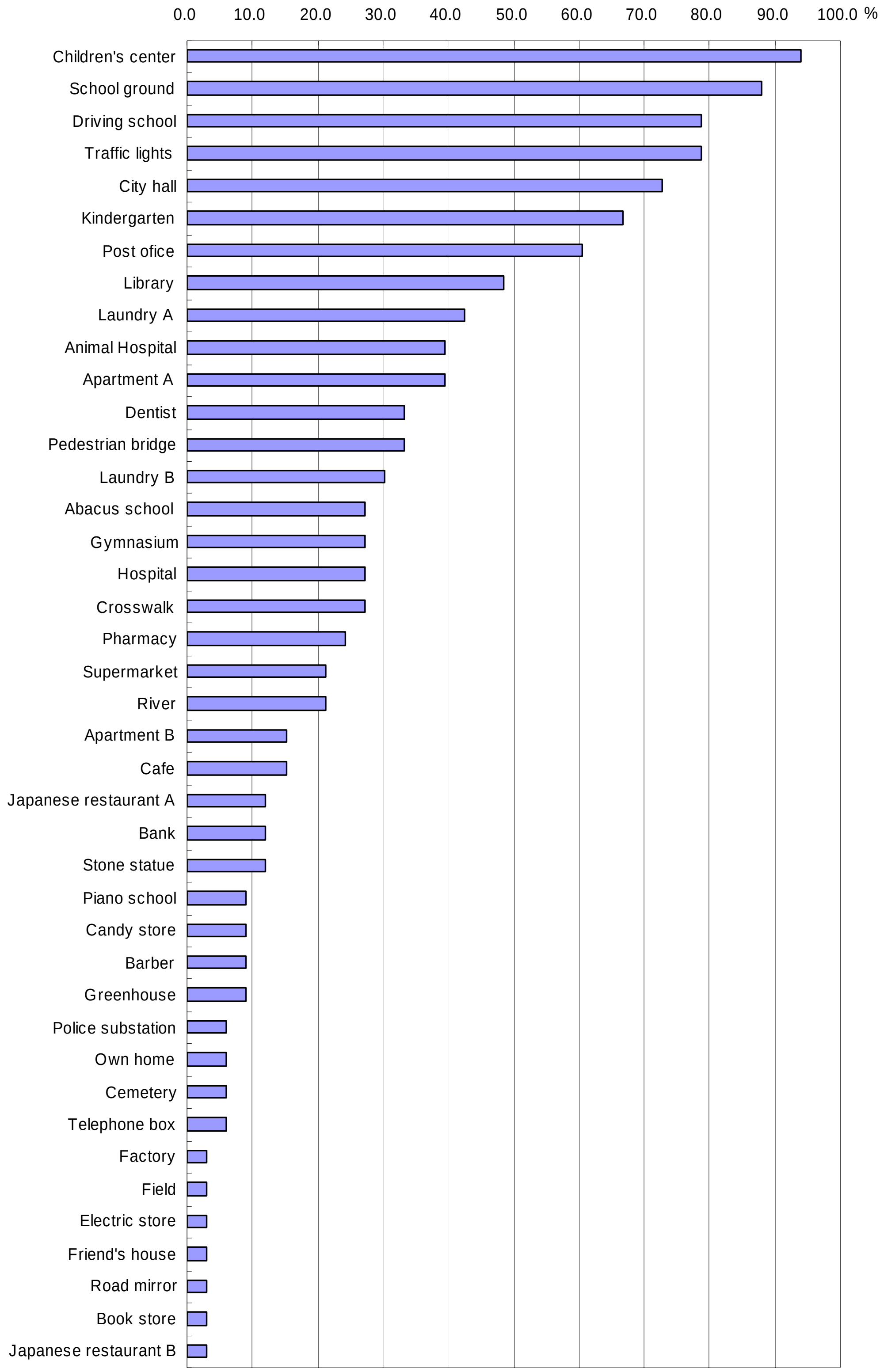


Figure 3-10 Items marked on the map by pupils

For most of these 3rd grade pupils it was their first experience to use a map. They had not learnt how to read maps before, so it was quite natural that they could not manage to read the map well. They had just started to study with maps. Such elementary school pupils in the lower grades need more experience before they can understand that the map is the same as the real world and they are not lost and confused on the map. Nobody can read maps without learning map reading and navigation skills. In addition, as beginners they need a map with more information such as well-known buildings or landmarks to understand their position and other objects around them.

3.3 Viewpoint of secondary school students' map reading

Lower and upper secondary students move in a wider range area than elementary school pupils. Furthermore, they have developed spatial cognition and have used maps in social studies in elementary school, even though there is no mention of lessons to teach map skills as a unit in the national curriculum standards. So students in secondary education are believed to be able to read maps in some way.

What do students in lower and upper secondary schools refer to in order to find their own position or a specific object and understand what the map is showing? The author conducted an inquiry survey of students in secondary education to clarify the tendencies of their reference points when they read maps.

3.3.1 Outline of the survey

The surveys were conducted of 8 2nd grade students at Minami Junior High School in Tamamura town, Gunma prefecture, on 10th June, 2007, and of 12 2nd grade and 38 1st grade students at Takasaki High School, Gunma prefecture, on 19th September, 2007 and 23rd January, 2008.

The question they were asked was, “What kind of information do you need in order to find yourself on the map? Choose 5 elements in order of descending priority.” The options were the shape of the roads, shape of the buildings, place names, intersection names, names of buildings, map symbols, scale, bearings, shape of intersections and others. The number of valid responses was 7 in lower secondary school and 43 in upper secondary school in total.

3.3.2 Reference points of lower secondary students

Lower secondary school students consider the names of the buildings to be the most important, with the shape of the buildings ranked second (Table 3-1). On the whole, all the students chose the name of the building and the shape of the road, and the shape of the building was also chosen by many students. Especially with regard to the name of the building, most students chose this as the most important element for reading the map. In contrast, the shape of the road seemed to have low priority.

3.3.3 Reference points of upper secondary students

Although the surveys were conducted of 1st and 2nd grade students,

Table 3-1 Lower secondary school students' reference points for reading maps

(n=7)

Importance	1st	2nd	3rd	4th	5th	Total
Shape of road	1	1	2	0	3	7
Shape of building	0	3	3	0	0	6
Place name	0	0	0	3	1	4
Name of intersection	0	0	1	1	0	2
Name of building	5	1	0	1	0	7
Map symbols	1	1	0	2	0	4
Scale	0	0	1	0	0	1
Bearings	0	1	0	0	3	4
Shape of intersection	0	0	0	0	0	0

Table 3-2 Upper secondary school students' reference points for reading maps

(n=43)

Importance	1st	(%)	2nd	(%)	3rd	(%)	4th	(%)	5th	(%)	Total	(%)
Shape of road	10	(23.3)	6	(14.0)	4	(9.3)	11	(25.6)	4	(9.3)	35	(81.4)
Shape of building	5	(11.6)	5	(11.6)	8	(18.6)	2	(4.7)	3	(7.0)	23	(53.5)
Place name	3	(7.0)	6	(14.0)	5	(11.6)	6	(14.0)	5	(11.6)	25	(58.1)
Name of intersection	2	(4.7)	2	(4.7)	1	(2.3)	6	(14.0)	5	(11.6)	16	(37.2)
Name of building	16	(37.2)	4	(9.3)	4	(9.3)	4	(9.3)	4	(9.3)	32	(74.4)
Map symbols	2	(4.7)	1	(2.3)	8	(18.6)	3	(7.0)	8	(18.6)	22	(51.2)
Scale	1	(2.3)	1	(2.3)	0	(0.0)	1	(2.3)	1	(2.3)	4	(9.3)
Bearings	4	(9.3)	7	(16.3)	5	(11.6)	2	(4.7)	5	(11.6)	23	(53.5)
Shape of intersection	0	(0.0)	3	(7.0)	2	(4.7)	1	(2.3)	4	(9.3)	10	(23.3)
Others/NA	0	(0.0)	0	(0.0)	2	(4.7)	1	(2.3)	1	(2.3)	4	(9.3)

common features were observed. First, they chose the name of the building (37.2％, 16) and the shape of the road (23.3％, 10). As their second reference point, though there were no outstanding elements, students answered bearings (22.6％, 7), the shape of the roads, buildings and intersections, and text information such as place name or building name. These were followed by map symbols and the shape of the roads (Table 3-2).

As a whole, the shape of the roads was chosen by 81.4% of students (35), then names of buildings (74.4％, 32), and more than half of the students referred to the names of places, shape of buildings, bearings and map symbols.

3.3.4 Similarities and differences of reference points between lower and upper secondary students

Lower and upper secondary school students have some reference points in common when they read maps. One is that the names of the buildings were the most important information for many students, and the other is that almost all the students referred to the shape of the roads. These tendencies derived from their behavior whereby they find landmarks which they know and find their own position in relation to these landmarks. As text information is easy to understand, students can easily understand what the map is showing. Then they try to find their correct position on the map using the shape of the roads around the landmarks. In addition to these two elements, they try to read the map accurately using other information such as names of places, shapes of buildings or map symbols.

The key differences between lower and upper secondary students are the kinds of reference points they use and how they use the information. Lower secondary students chose a few reference points such as the names and shapes of the buildings or the shapes of the roads. Upper secondary school students used not only the reference points that the lower secondary school students chose, but also a wide variety of other elements. Lower school students tended to use the names of buildings, secondly the shape of the buildings, and then the shape of the roads. In the case of upper secondary school students, many of them used the shape of the roads first and then used other information such as bearings or the shape of intersections.

Lower secondary school students find themselves or objects by referring to point-type information. This might indicate that they still view the map from ground level. Upper secondary school students use more linear or spatial information such as the shape of the roads or intersections or bearings. This is because they can grasp a wide area spatially and reflect what they see in the real world on the map. In other words, some of them have already acquired bird’s eye views, and they can find themselves on the map without resorting to only point information such as names or positions of landmarks.

3.4 Reference points by map reading skills

From the results of the reference points used by lower and upper secondary school students, it can be observed that the way of reading maps differs by age. These results seem to imply that people become able to read maps as they get older. But here arises one question. If map reading abilities develop with age, why can every adult not read maps? Some can read maps accurately, but others cannot understand maps. Are there any differences in how maps are read between adults who can read maps correctly and those who cannot?

The author conducted a survey to find the reference points for map reading by differences in map reading ability.

3.4.1 Outline of the survey

This survey was conducted to find the level of accuracy of map reading, to find whether respondents could find their own position on the map and plot other specified buildings, and to clarify the elements used as reference points to search for these objects. The survey was carried out of university students at Kanazawa University in June, 2004. The target area was the Kakuma campus of the university. The respondents comprised 35 students in the 1st and 2nd grade and the number of valid responses was 33.

In the survey, a large-scale map with compass bearing, scale, shapes of buildings and roads without text information was used (Figure 3-11). Students were asked to mark three buildings as landmarks and their own position at that time on the map. Furthermore, the survey asked them to indicate what elements they used in the decision making process to find the objects on the map.

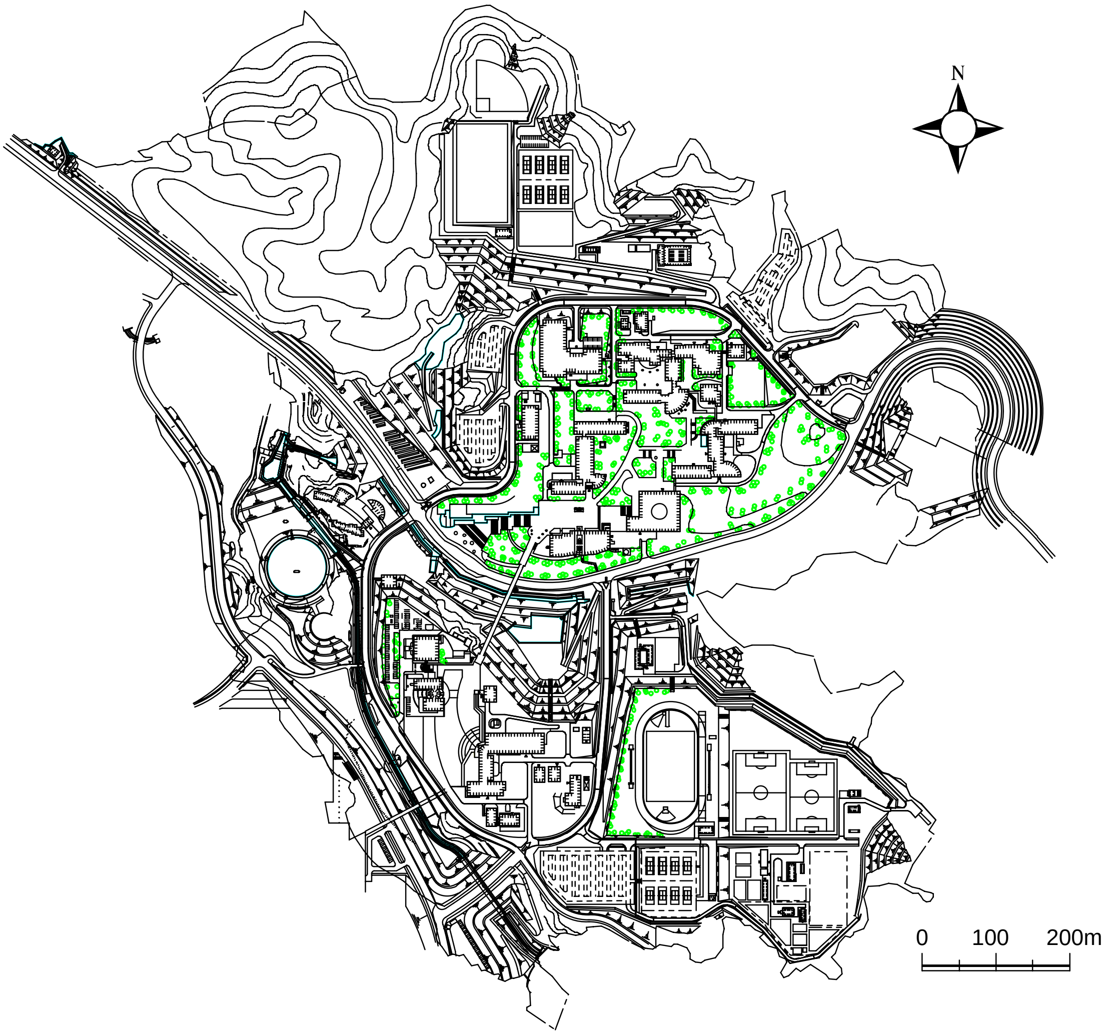


Figure 3-11 Map of Kanazawa University campus

3.4.2 Distribution of answers for each object

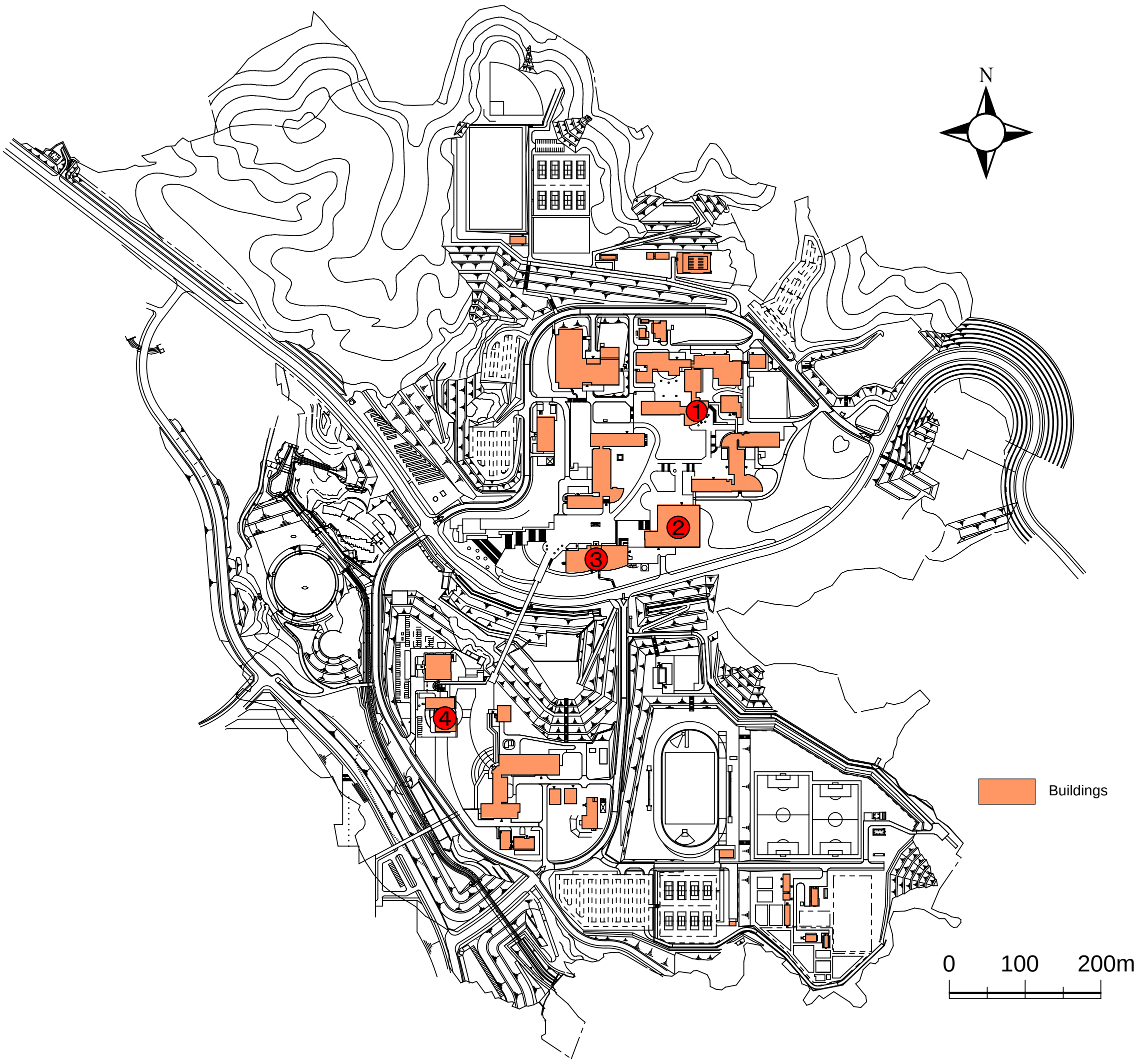
The buildings for the students to find on the map were the library, university hall and media center as well as the lecture building as the self-position. These are facilities that the students use frequently and are unique in appearance. To the students participating in the survey, the images and names of the library, university hall and media center were given as ancillary information (Appendix 3-1). With regard to the lecture building as the self-position, as the building itself is huge, the students were asked to mark the position of the lecture room in the building where the students were answering the survey.

The library, the university hall and the lecture building where the students answered these questions are on the north side, and the media center is located on the south side of the campus (Figure 3-12). The campus of the university is divided into two areas by a road, but the divided areas are connected by a pedestrian bridge.

Figure 3-13 shows the distribution of points for each building which the students marked on the map. X indicates a point marked by a student.

About 80% of the students (27) correctly plotted the location of the lecture building where they were. Although the incorrectly marked points were near the lecture hall, the distribution of answers varied because the building is complex in structure.

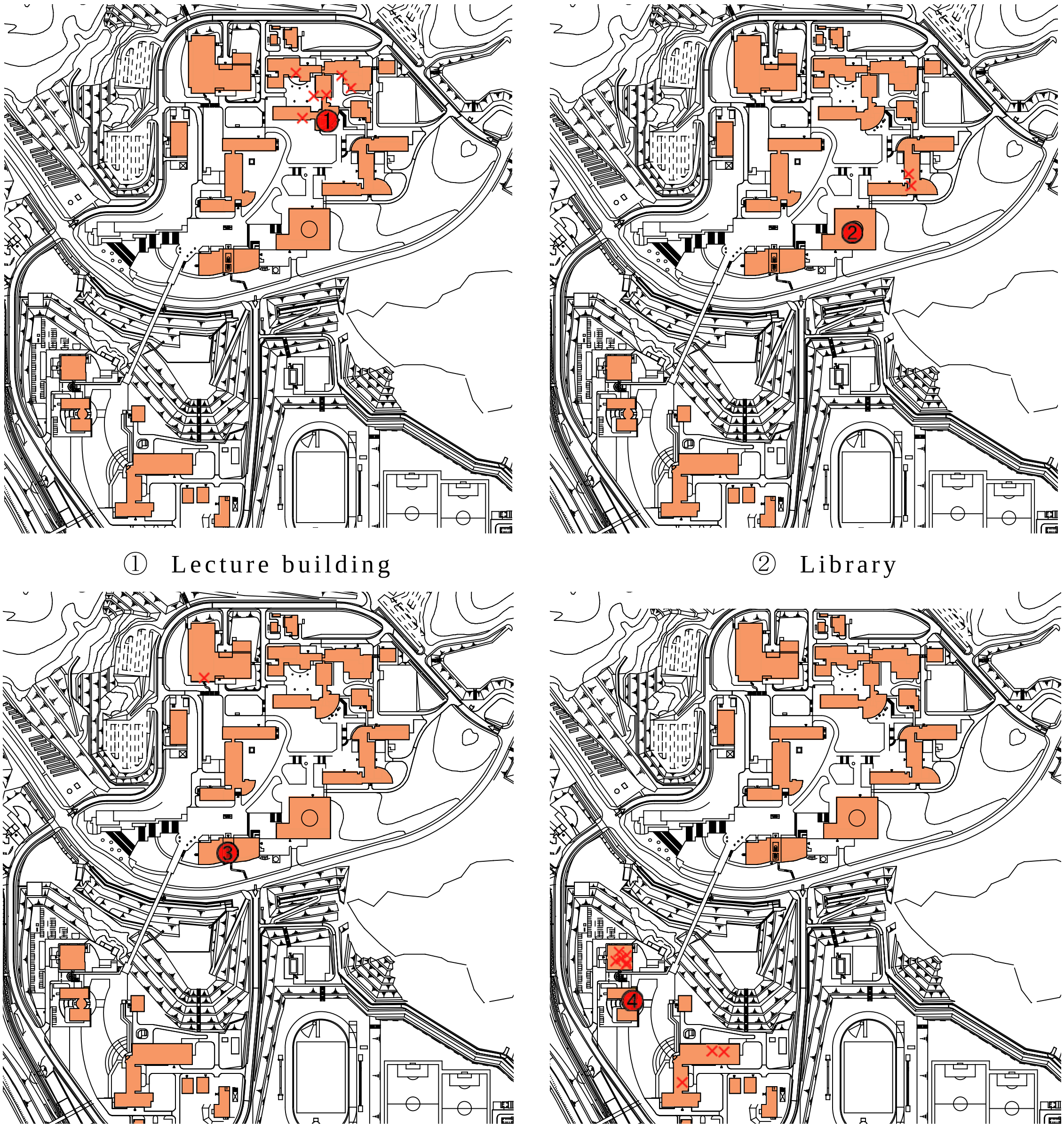
The library had the second highest percentage of correct answers. 93.9％ of students (31) accurately plotted its position. The library is an essential part of campus life and has many visitors and a unique shape, therefore many



① Lecture building (Self-position)　② Library

③ University Hall　④ Media Center

Figure 3-12 Objects to find on the map of Kanazawa University campus



① Lecture building　② Library

③ University hall　④ Media center

X Point marked by student

Figure 3-13 Distribution of incorrect points for each object marked by students

Table 3-3 Grouping by tendency of answers on the locations of the objects on the map and number of students in each group

(%)

Group	Library	University Hall	Media center	Lecture building (self-position)	Total
A. Students recognized all buildings and self-position correctly	19 (57.6)	19 (57.6)	19 (57.6)	19 (57.6)	19 (57.6)
B. Students recognized self-position correctly but were mistaken about other buildings	7 (21.2)	8 (24.2)	1 (3.0)	8 (24.2)	8 (24.2)
C. Students did not know their self-position	5 (15.6)	5 (15.6)	4 (12.1)	0 (0.0)	6 (18.2)
Total	31 (93.9)	32 (97.0)	24 (72.7)	27 (81.8)	33 (100.0)

students could answer easily.

Almost all the students (32 out of 33) plotted the position of the university hall correctly. This is because the university hall has a large dining hall and shops, so many students may use this facility regularly. The media center had the lowest percentage of correct answers at about 70% (24). Most of the wrong answers indicated the building next to the media center.

Based on the accuracy of the answers, the students were divided into 3 groups. Group A consists of members who can recognize their self-position as well as all the other buildings correctly on the map. In Group B members can recognize their own position, but make some mistakes regarding other buildings. Group C members do not know where they are on the map. Group A accounts for 57.6％(19,) Group B 24.2％ (8) and Group C 18.2％(6, see Table3-3). The percentages of correct answers on self-position and the three other buildings are 100% for Group A, 75% for Group B and 58.3％ for Group C.

3.4.3 Differences among groups in ways of finding position or objects on the map

1) Group A

When they started to look for a building, most of them considered the positional relation to other buildings or objects (Figure 3-14). For all the objects, more than 60% of respondents referred to this element. To find the lecture building and the media center, which students mistook in other groups, they considered the shape. Also, the distance from other buildings

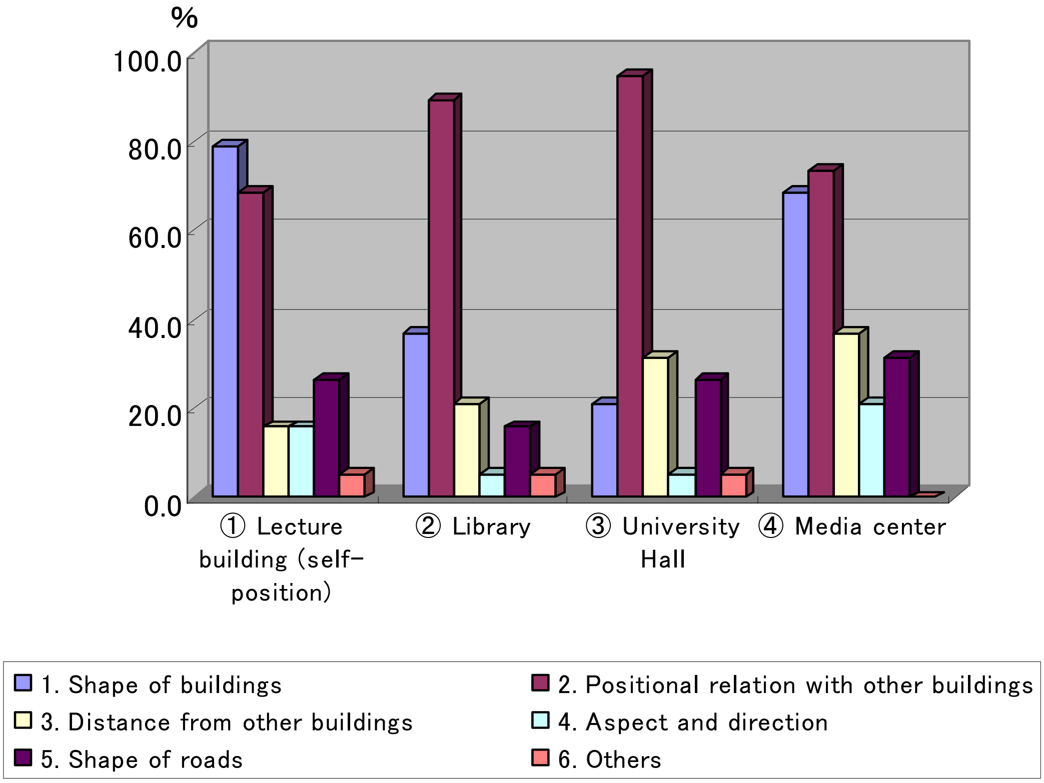
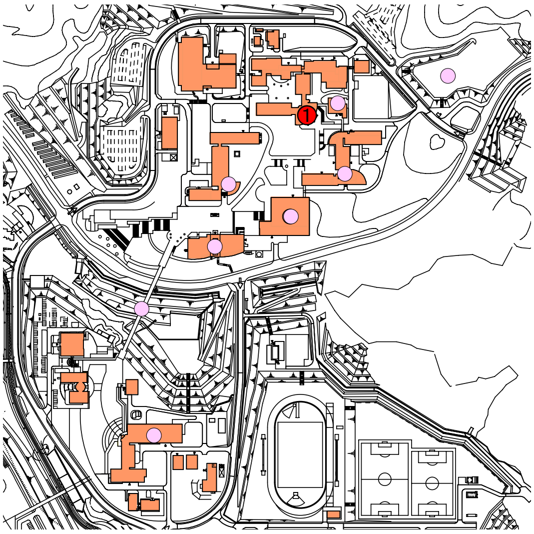
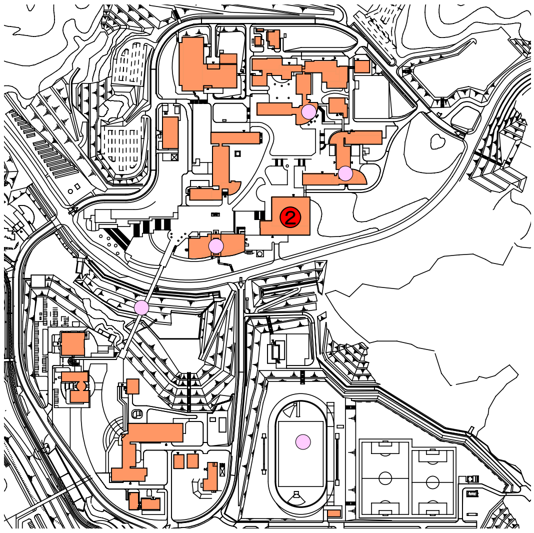


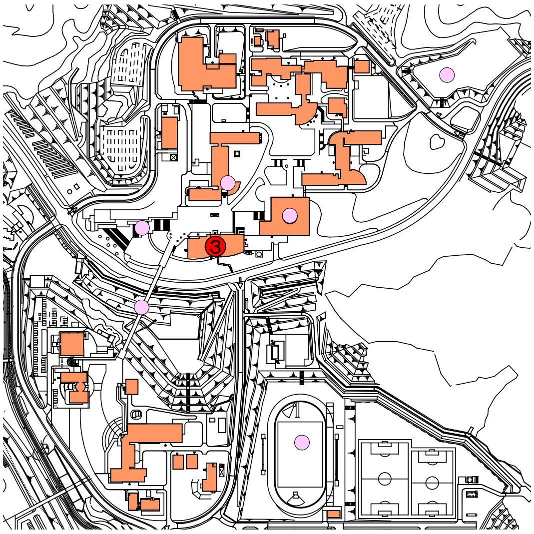
Figure 3-14 Ways used by each group to find the location (Group A)



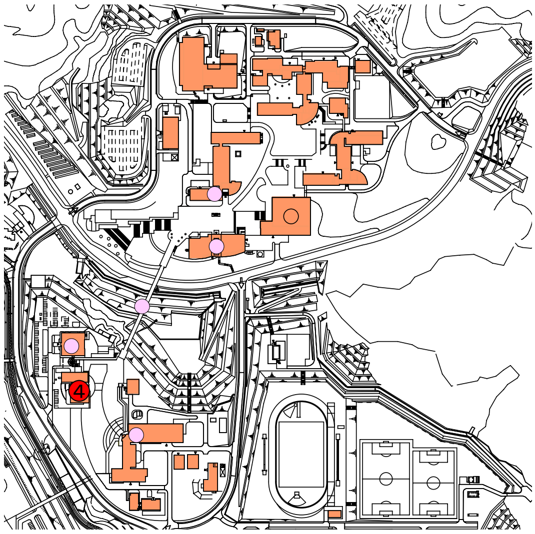
① Lecture building (self-position)



② Library



③ University hall



④ Media center

○ Reference point

Figure 3-15 Reference points used by each group to find the location (Group A) and the shape of the road on the campus were added as elements to find the targets.

The reference points which students in this group mentioned [2)] were varied and their distribution covered a wide range (Figure 3-15).

As above, the respondents who marked the location of the buildings on the map correctly seemed to be able to read the map by looking not only at the building itself, but also at other buildings and roads. They may have already acquired wide-range spatial cognition and the ability to see the real world in relation to the map.

2) Group B

The respondents in this group identified their self-position on the map but made some mistakes marking the other buildings. In particular, only 12.5% of students plotted the location of the media center accurately. They marked places near the media center, but most of them mistook the building next door for the media center.

In this group, the positional relation of the buildings was the primary method of locating the objects on the map (Figure 3-16). The shape of the buildings was also an important element in finding the lecture building and the library. But to find the university hall and the media center, the respondents did not consider these elements so much. For all the objects, the respondents did not take into account the distance between buildings or other objects.

In this group, a distinctive feature was the answer ‘direction, bearing’ for the media center. It is likely that students already knew of the existence of

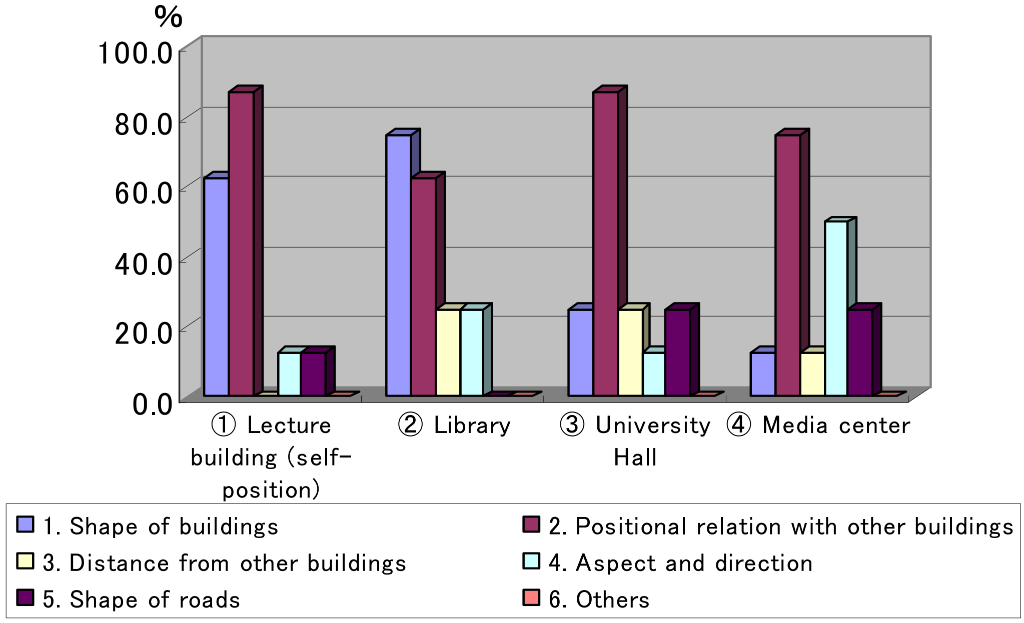
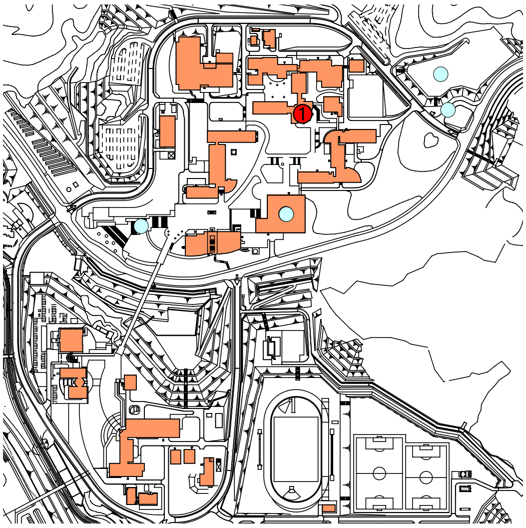
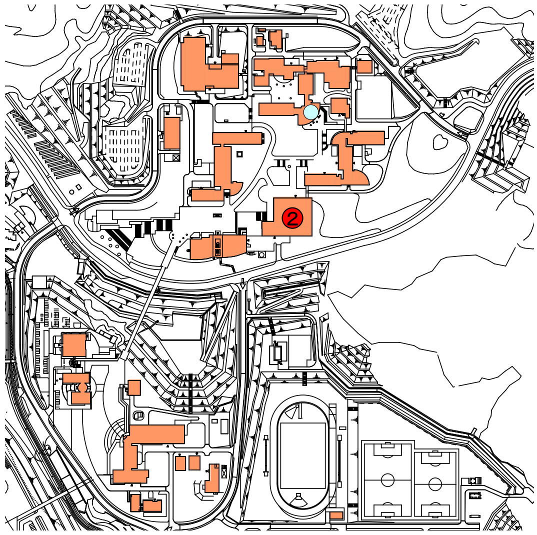


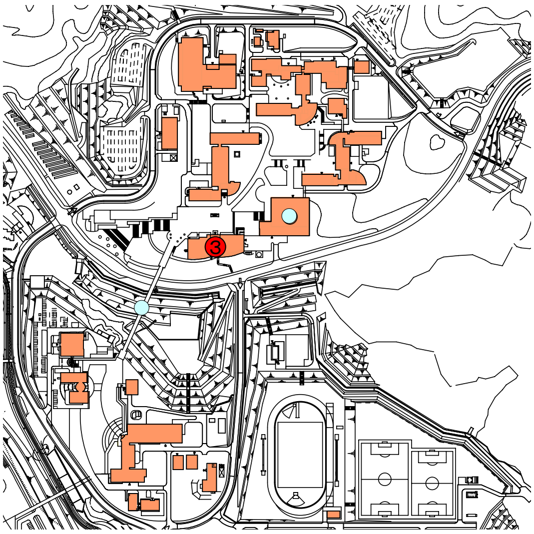
Figure 3-16 Ways used by each group to find the location (Group B)



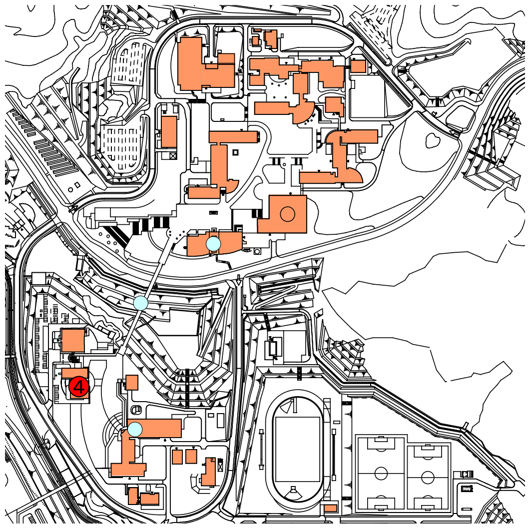
① Lecture building (self-position)



② Library



③ University hall



④ Media center

Reference point

Figure 3-17 Reference points used by each group to find the location (Group B) the facility itself and the direction of the center. Yet their recognition of the location of the building was vague and they perhaps depended on the compass bearing to find the object. Also, they did not use the information on the shape of the buildings. Although images of each building were provided in advance, they did not assume the shape of the building from the photos.

Compared to Group A, the reference points were less varied and comparatively near the objects that they were asked to find (Figure 3-17).

3) Group C

This group consists of respondents who did not know where they were on the map and plotted the objects incorrectly on the map. The way of identifying the objects in this group was almost solely by considering the positional relation to other buildings and objects (Figure 3-18). In addition, the elements which the respondents used were less varied and fewer (Figure 3-19). They tried to find the objects with few reference points.

The respondents in this group are similar to persons without map literacy. They are characterized by the fact that they only considered the positions of the objects and a few other buildings and did not use any other elements such as the shape of the roads or buildings.

3.4.4 Reference elements for map reading

Are there any differences in the elements used to read maps by level of map reading ability? Table 3-4 shows the elements that the respondents in each group used when they read the map. Here we can take Group A as a group of students with map literacy, Group B as a group of students who can

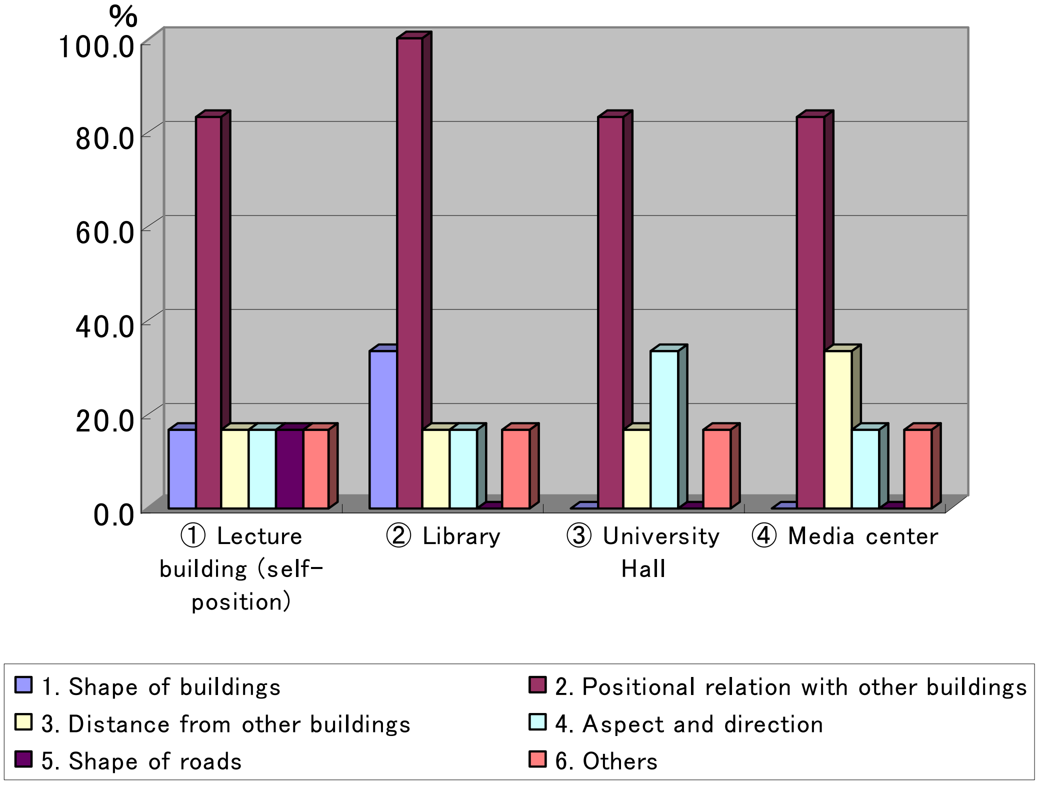
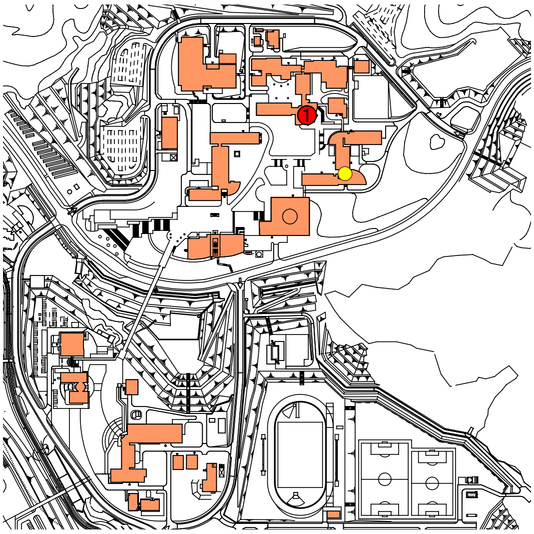
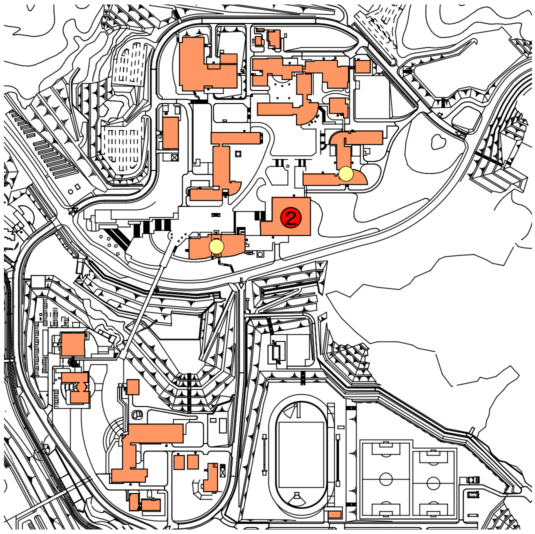


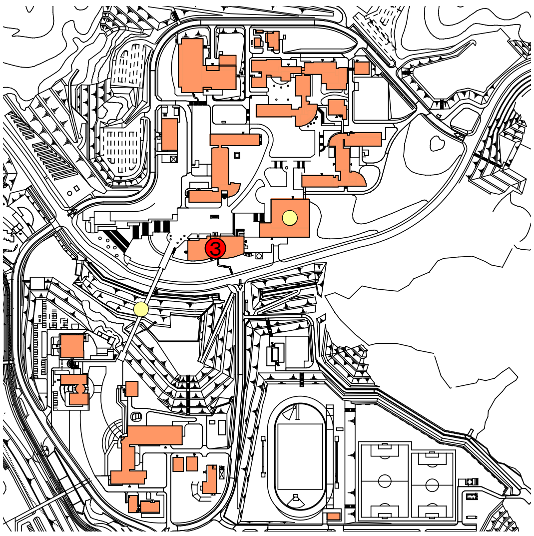
Figure 3-18 Ways of identifying the location of each object (Group C)



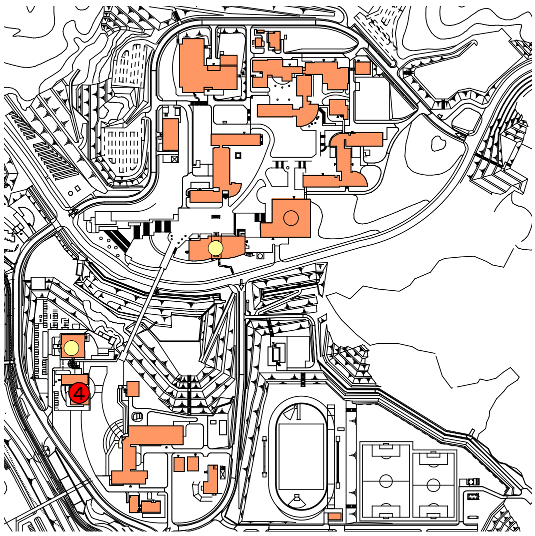
① Lecture building (self-position)



② Library



③ University hall



④ Media center

○ Reference point

Figure 3-19 Reference points used by each group to find the location (Group C)

Table 3-4 Reference points to read the map

	Group A n=19		Group B n=8		Group C n=6	
		(%)		(%)		(%)
1.Shape of roads	12	(63.2)	2	(25.0)	1	(16.7)
2.Location of roads	9	(47.4)	4	(50.0)	3	(50.0)
3.Shape of intersection	3	(15.8)	3	(37.5)	0	(0.0)
4.Location of intersection	12	(63.2)	4	(50.0)	2	(33.3)
5.Shape of building as a landmark	8	(42.1)	3	(37.5)	2	(33.3)
6.Location of building as a landmark	16	(84.2)	7	(87.5)	3	(50.0)
7.Shape of blocks	5	(26.3)	1	(12.5)	2	(33.3)
8.Location of blocks	2	(10.5)	0	(0.0)	1	(16.7)
9.Distance between points	2	(10.5)	0	(0.0)	1	(16.7)
10.Bearings	3	(15.8)	0	(0.0)	2	(33.3)
11.Place name	13	(68.4)	5	(62.5)	3	(50.0)
12.Map symbols	1	(5.3)	0	(0.0)	1	(16.7)

manage to read maps, and Group C as a group of students without map reading abilities. As with the method of searching for buildings on the campus, the number and types of information for map reading decrease in order of Group A, B, and C.

One element common to all groups is that landmarks are important when searching for objects. Respondents in Group C tended to rely on point-type information such as landmarks and text data such as names of places. In Group B, some respondents included information on the shape of the intersection, but they still depended very much on landmarks and names of places.

However, respondents who recognized their self-position and the locations of other buildings looked not only at the location of landmarks but also at the shape and position of roads, the location and shape of intersections and the shape of blocks. This means that they read a variety of information from the map and could recognize the described area as a continuous area.

As above, people who can read maps correctly and pinpoint their exact location on the map refer to various elements to confirm the location of each object. In particular, they rather use spatial elements such as the shape of the roads or blocks surrounded by streets.

On the other hand, people who cannot read maps and do not know or mistake where they are on the map only use point-type elements such as the location of certain buildings or text showing the names of places or objects. This tendency of students to rely on landmarks when searching for objects on the map is considered a children's trait according to previous studies (Siegel and Schadler 1977, Acredolo 1977, Evance 1980). Grown-up persons who cannot read maps still read maps like a child developing spatial cognition.

3.5 Map reading, map education and GIS in education: conclusion

In considering GIS for education, this chapter clarified how students from elementary school to university, as potential GIS users, read and understand maps.

Tendencies in map reading from elementary school pupils to university students are very interesting. Pupils in 3rd grade at elementary school try to read maps using the few tips they know. They can rarely find objects which are outside the field of their activities and they are not familiar with, even though they may have seen them.

Lower secondary students prioritize text data such as the names of buildings or places that show point-type data when reading maps. These textual data provide intuitive information, so students can make correlations between objects indicated by these data and what they already know. Furthermore, they can easily find their own location or objects they are looking for by analogy with such data.

Upper secondary school students tend to find objects using spatial information such as the shape of the roads or crossings or the compass bearing. They depend on line or plane elements such as the shape of the roads rather than landmarks or points. In this case, the names of buildings or places or locations of buildings play a role in assisting in the search for

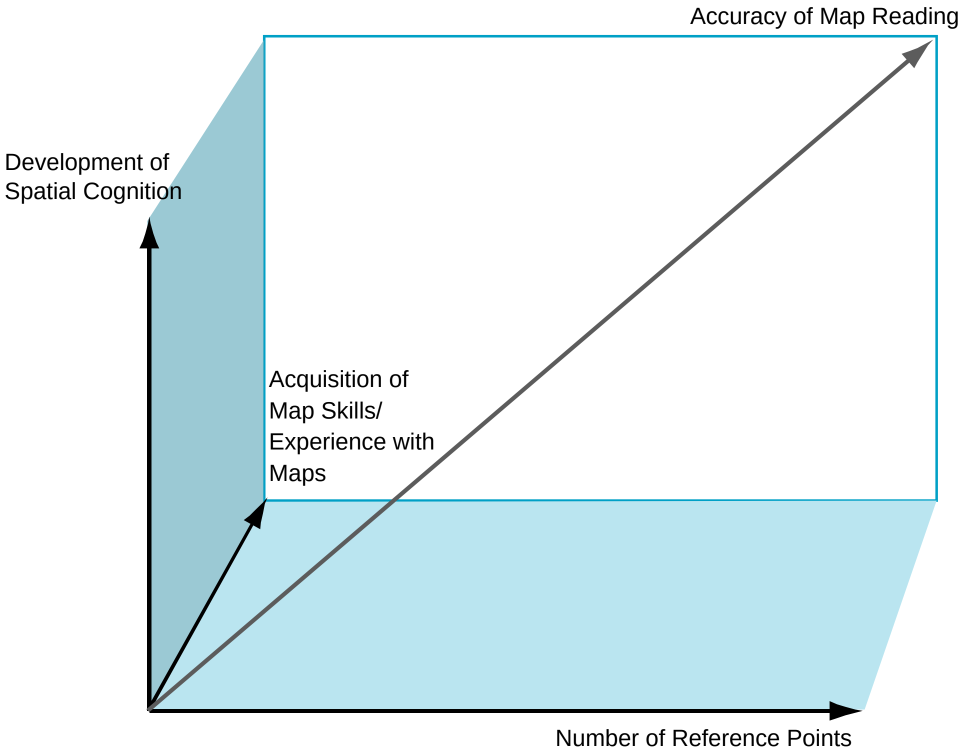


Figure 3-20 Map literacy development model

objects. At the same time, there are some students who still use the method which was observed among lower secondary school students to find objects by place names.

The differences between lower and upper secondary school students showed the same tendency as the results for university students. The method observed often among upper secondary school pupils is similar to the method observed in the group of students with precise map reading ability. Also, the method observed among lower secondary school pupils shows the same tendency as the group of students who cannot read maps.

Differences in accuracy of map reading are related to spatial cognition and the number of elements used as references. Compared to lower secondary students, the tendencies seen among upper secondary students are similar to those of the group that can read maps accurately.

Development of spatial cognition and experience of using maps that come with age may be connected with the development of map reading skills. And a person who can read maps accurately uses more reference points. Conversely, a person who uses many reference points tends to be able to read maps more accurately. Figure 3-20 shows that the development of map reading accuracy can be explained by the relationship of level of spatial cognition, map skills and number of reference points used when a person reads maps.

Map reading skills are acquired by learning. At present, the national core curriculum does not include any units on acquiring map literacy, that is to say, the content of education today has no foundation on which to introduce GIS. GIS basically requires map reading skills. As map education is lacking in school education, it may not be effective to use GIS in education.

In the future, GIS will become an indispensable tool in society. From the point of view of nurturing future GIS users, map education is essential in school education. In particular, elementary school pupils should learn how to read and understand maps and use maps to lay the groundwork for using GIS. After then, in secondary education, discussion may be possible if teachers introduce GIS in classes. Consequently, map education should be introduced at the national core curriculum level.

To use maps in class, maps must be selected according to students' knowledge and map skills, level of spatial cognition and lesson content. It is the same for GIS. It is also important to improve the usability of the applications. In addition, maps with names of buildings and places or point data on landmarks help users to recognize and understand correctly. By using such user-friendly maps with GIS, it will be possible to support map education and classes using maps with this system. Using base maps with subsidiary information might make up for map education. GIS used by the students themselves is especially difficult to introduce at present. It will be worthwhile to develop GIS from the perspective of students who cannot read maps or have not learnt map reading skills.

Notes

1) In Amano et al. (2003) the term "kaado echizu (card picture-map)" is used in explanations of the presentation, but other life studies textbooks do not use the term "chizu (map)" at all.

2) Although all respondents mentioned the reference points for each object, the points helped to reveal what the respondents used to read the map.

References

Acredolo, L. P. 1977. Developmental changes in the ability to coordinate perspectives of a large-scale environment. *Development Psychology*, 13, 1-8.

Amano, M., Terao, S., Aibe, Y., Abe, O., Ohno, Y., Kajiwara, Y., Sakado, H., Sawamoto, K., Sugusawa, M., Takemura, S., Takeyama, T., Tanaka, H., Tsukada, Y., Terakawa, T., Terashi, N., Naka, M., Nakano, M., Wakabayashi, T., and Shinko publishing Keirinkan editorial department 2003. *Iki iki seikatsu: Ge (Active life for 2nd grade)*. Keirinkan.

Evance, G. 1980. Environmental cognition. *Psychological Bulletin*, 88, 259-287.

Golledge, R. G. 1978. Learning about urban environments, In *Making sense of time*, ed. Carlstein, T., Parkes, D. and Thrift, N., Edward Arnold, 76-98.

Iwado, S. and Sashima, M. 1977. Shogakko ni okeru kukan ninshiki no hattatsu ni kansuru kenkyu -supesu no kotonaru chizu hyogen no baai (Study on development of spatial cognition in elementary school: in case of expressions of maps with different space). *Chizu (Map)*, 15-2, 23-32.

Iwamoto, H. 1984. Shogakko ni okeru chizu gakushu wo megutte (Discussion on map study in elementary school). *Chiri (Geography)*, 29-11, 128-137.

Ministry of Education, Culture, Sports, Science and Technology 1998. *Shogakko Gakushu Shido Yoryo (National Curriculum Standards for Elementary School)*. Tokyo: MEXT.

Ninohira, A. 1977. Byosha ryoku no hattatsu to sono keihatsu (Development of depiction skill and its education). *Shin chiri (New Geography)*, 25-2, 40-56.

Shinohara, S. 1993. Daigakusei no dokuzu noryoku kara mita chizu kyoiku no mondaiten (Problems of map education from the point of view of university students' map reading abilities). *Kagawa daigaku kyoiku jissen kenkyu (Bulletin of Educational Research and Training of Kagawa University)*, 20, 85-102.

Siegel, A. W. and Schadler, M. 1977. Young children's cognitive maps of their classrooms. *Child Development*, 48, 388-394.

Teramoto K. 1994 *Kodomo no chikaku kankyo: asobi, chizu, gen fukei wo meguru kenkyu (Children's perceptual environment: study on playing, map and primal scene)*. Chijin shobo.

Wakabayashi, Y. 1999. *Ninchi chizu no uukan bunseki (Spatial analysis of cognitive map*). Chijin shobo.

Chapter 4. Development and experimental study of 'Cellular Phone GIS' as utilizable GIS in education

4.1 Introduction

4.1.1 Review of previous works on education and GIS

Nowadays, it would not be an exaggeration to say that GIS is here to stay. Car navigation systems and web map services like Google Maps with GIS in the background are already used in many aspects of our lives.

In the education field in Japan, utilization of GIS has been expected since an explanation of GIS appeared in upper secondary school geography textbooks in 1995. This expectation comes from two perspectives: the advantages in education of utilizing GIS and the government's information technology and education policies.

There are some discussions about the effectiveness of utilizing GIS in primary and secondary education in various dimensions. The first is the point of view regarding the characteristics of GIS and the quality of education, in other words, that teachers can make original maps which students can understand easily using GIS, enabling the arrangement or revision of many kinds of maps such as thematic maps and general maps, and thereby leading to better classes. Another discussion concerns students' involvement in classes utilizing GIS. Students themselves operate GIS and analyze the results displayed by GIS, giving rise to the opinion that GIS is effective for cultivating spatial cognition and a geographical perspective and way of thinking. Also, there are some examples that indicate that fieldwork using GIS makes students motivated or positive (Tinker 1992, Baker and White

2003, Kerski 2003, Johansson 2006.) Such works were welcomed expectantly in the field of geography and in other areas such as environmental education and urban engineering.

Also, government policy toward digitization of education raised hopes for using GIS in schools. In 1999, government-led projects such as ‘Kodo johoka shakai suishin ni muketa kihon hoshin- akushon puran (Basic policy for advanced information and telecommunication society - Action plan)’ (Headquarters for the Promotion of an Advanced Information and Telecommunications Society, 1999) and the ‘Millennium Project’ (Cabinet Office, 1999) emphasized “digitization of education.” The ‘e-Japan strategy’ in 2001 (Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society, 2001) also gave priority to digitization of education as strengthening human resource development. Since then, the environment of computers and networks in school has improved rapidly all over the country and computers and the Internet have been incorporated into lessons. These policies should serve as a spur to GIS in education which needs a computer environment.

Previous studies have expressed expectations of introducing GIS in the education field in Japan. Akimoto (1996) explained about GIS and discussed the problems of introducing GIS into upper secondary schools. Itoh et al. (1998a) and Itoh (1999) explained trends and examples in the United States and mentioned the possibilities of introducing GIS into school education. About the possibilities of introducing GIS into classes, Ozeki and Hayakawa (2003) considered GIS the ideal support for the chorographical method.

Fukuda and Tani (2003) conducted an inquiry survey targeted at teachers and discussed how GIS can be utilized in geography education in upper secondary schools. Itoh and Ugawa (2001) examined the possibilities of using GIS in environmental education through practical use of GIS.

Also, some motivated secondary school teachers who are interested in GIS tried conducting classes using GIS software (e.g. Kobayashi 2001, Tani et al. 2002, Tatsuoka 2002). These studies emphasized the advantages to education such as developing students' spatial cognition using maps, the characteristics of software that can generate many kinds of maps immediately, and the benefits of using networks to share information on computers.

Previous studies have underlined the fact that GIS is not used in school education. That is why many scholars and teachers who are familiar with GIS have explained the benefits of using GIS and suggested ways of using it. Although such efforts have continued for more than a decade, GIS has still not been introduced into schools yet.

Obstacles to introducing GIS into school education are assumed to be the national curriculum standards, the computer and network environments in schools (Minamino 2003), and time constraints because introducing GIS requires a great deal of time to install GIS on the computers, input data and teach students computer literacy, map reading skills and the basics of GIS. However, it is thought that GIS will improve the quality of education and support classes, although the possibility is also pointed out that teachers and students may be burdened by introducing GIS (Yuda and Itoh 2007).

4.1.2 Integration of fieldwork, mobile GIS and cellular phones

In geography textbooks in lower and upper secondary education, fieldwork is recommended. GIS manages data using position information including data. In fieldwork, large amounts of data on an area are recorded. Ordinarily, paper maps and notebooks are the recording media for recording land use and the number of stories of buildings in the research area. With GIS, it is possible to process, edit, visualize, analyze and share data collected using paper maps and notebooks. From this point of view, some case studies on fieldwork using GIS have been conducted. Ugawa and Itoh (2002) and Yang et al. (2001) reported environmental studies using WebGIS. Sugimori (2004) combined digital image data with GPS, and then put the processed data on the map. And Mizutani et al. (2007) used a PDA-sized GIS terminal ‘ArcPad’ developed by ESRI.

In any case study, all the data collected using maps, notebooks and digital cameras need to be input into a computer in order to integrate the data after the fieldwork. In other words, the same data is written or input many times and cannot be analyzed before input. Furthermore, it sometimes happens that the wrong information is recorded, notebooks or maps including important data are lost, data is wrongly input or input of data to the database on the PC is unconsciously omitted.

Generally speaking, GIS is difficult to operate, especially for unskilled users. Not everybody doing fieldwork needs basic knowledge of GIS such as map projection, the concept of layers, types of data like vector or raster, and so on. Also, the level of map reading skills varies between individuals.

If GIS could be brought into use everywhere, users could input data there and then. The efficiency of the fieldwork would thus be further improved. If this ‘mobile’ GIS was connected to a network, it would be possible to store the data on the server. Accordingly, users could input, edit and process data in the field, and they would not need to make a new database or move data into desktop GIS after the fieldwork. Furthermore, as GIS has the function of showing maps of the research area in different scales, users could use GIS even without skills in map reading, experience of using GIS or knowledge of GIS.

One idea to realize these possibilities is integration of mobile GIS and cellular phones. Recently, GIS has improved functionally and improvement of hardware has made GIS portable. Therefore, ‘mobile GIS’ and its use have gradually expanded. Meanwhile, mobile phones are widely used and owned by many people in Japan. Cellular phones are widely used in our daily lives as communication tools and handheld terminal devices. According to the report on the growth of cellular phone use in Japan (Ministry of Public Management, Home Affairs, Posts and Telecommunications, 2004), since the mid-‘90s the number of cellular phone bearers has increased rapidly, and in 2006 the number of cellular phone subscribers was about 100 million (Figure 4-1).

In recent years, users use their cellular phones not only to make calls but also to exchange text messages. Cellular phone technology itself has made spectacular progress. Innovations include light weight with a built-in camera, high speed and broadband Internet access, so navigation services or Google

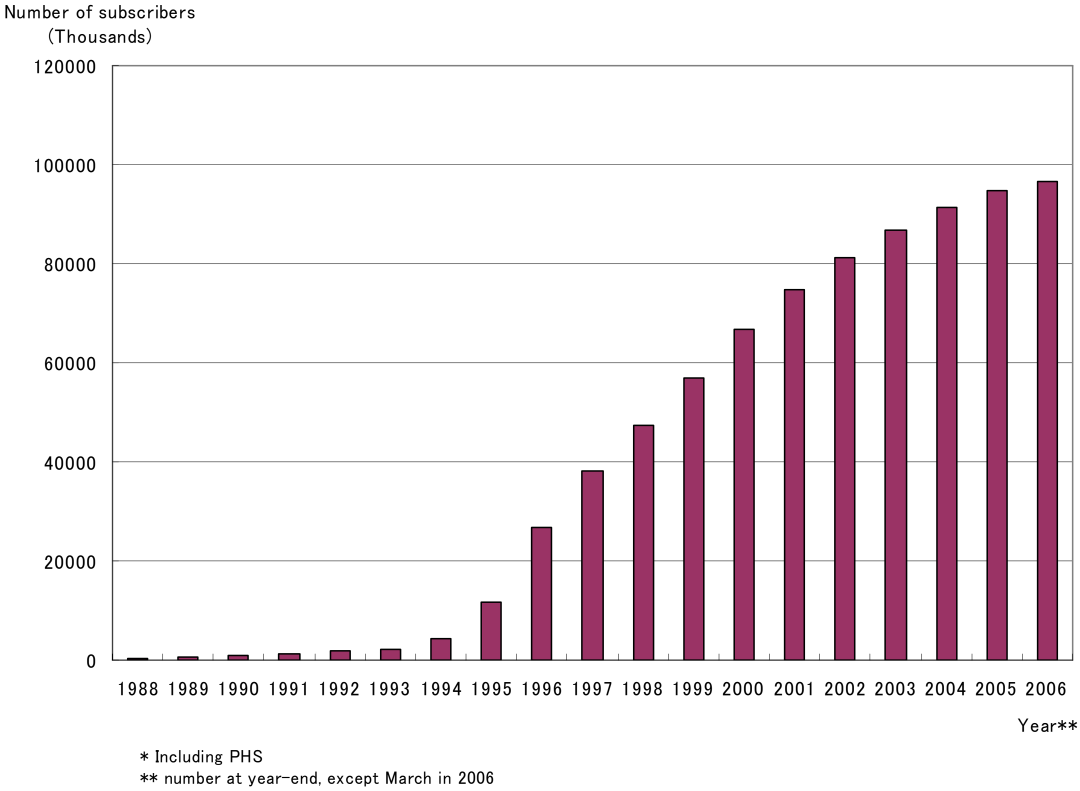


Figure 4-1 Shifts in number of mobile phone* subscribers in Japan

(Source: Ministry of Internal Affairs and Communications, 2006)

Maps can also be used on the mobile. These services using GIS are a popular feature of mobile phones.

Figure 4-2 shows the percentage of PC users and Internet access from PCs at each school level. Over three-quarters of elementary school pupils have a PC and nearly 60% of them connect to the Internet via the PC. More than 80% of lower and upper secondary school students have a PC and about 85% of them connect to the Internet using the PC.

The situation regarding mobile phones is that about 30% of elementary school pupils have cellular phones. In lower secondary school, more than half of pupils (57.6%) have cell phones, and almost all (96.0%) upper secondary school students have cell phones (Cabinet Office, 2007).

Furthermore, almost all mobile phone holders also connect to the Internet via their mobile phone. This result indicates that many students are familiar with mobile phones. Of course, they can manage their cellular phone with a practiced hand.

These actual conditions indicate that cellular phones with GIS have the potential to be a tool that will assist education. Additionally, as taking students out of school is a burden on teachers in lower and upper secondary schools, fieldwork is not practiced enough. In this situation, it is significant for education that GIS has acquired a mobile function using cellular phones which many students own and could be used easily outdoors.

Because of this situation, the author and colleagues developed 'Cellular Phone GIS.' This chapter aims to cover the development of 'Cellular Phone GIS' and evaluation of its effectiveness. The chapter starts by explaining

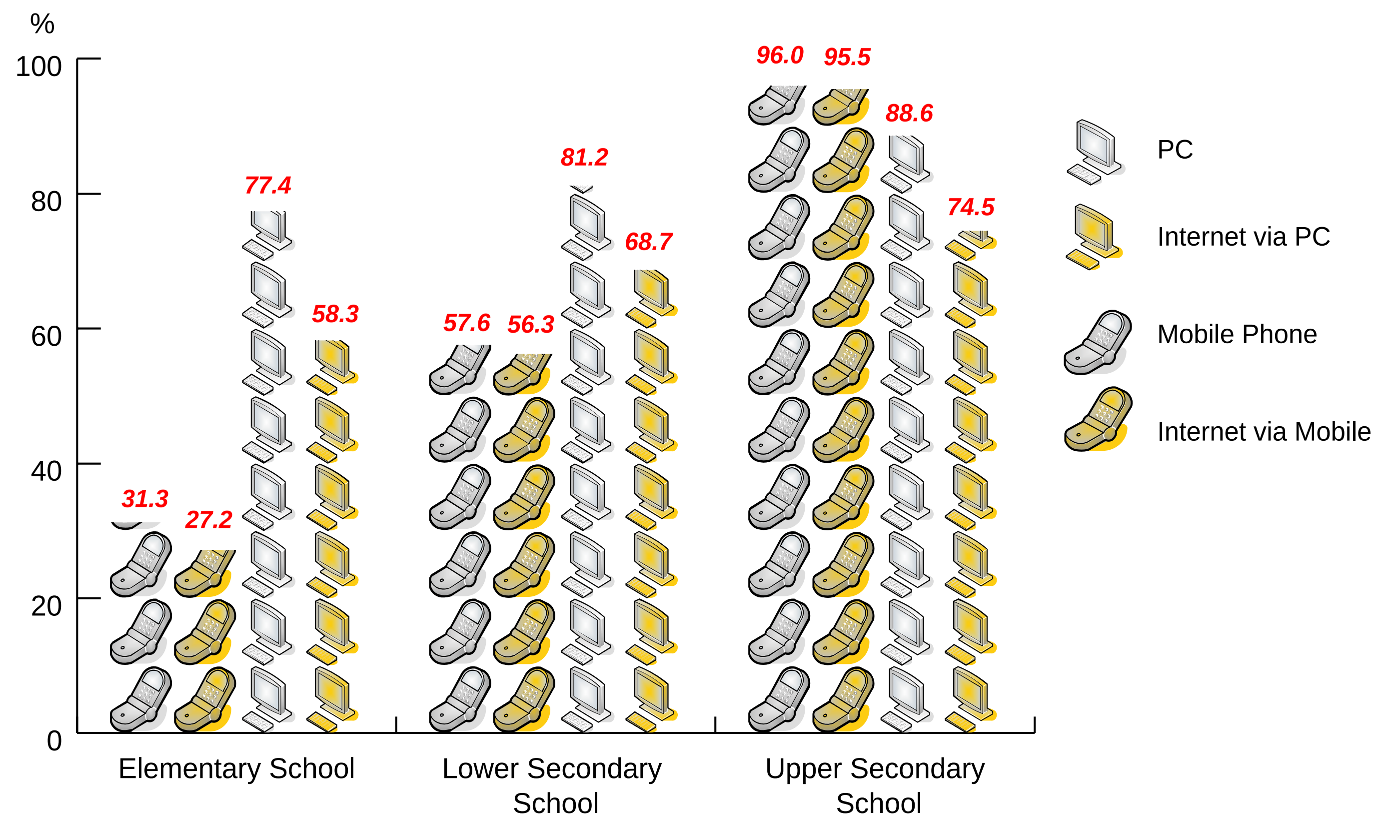


Figure 4-2 Percentage of PC, mobile phone and Internet users at each school level

(Source: Cabinet Office, 2007)

‘Cellular Phone GIS,’ then gives a comparison of the effectiveness of surveys using paper maps and notebooks and using Cellular Phone GIS that was conducted of university students. Classes using Cellular Phone GIS were also conducted in lower and upper secondary schools. Through these trials and evaluations by students, the author considers the effectiveness of GIS in school education.

4.2 Process and current situation of study and development of Cellular Phone GIS

4.2.1 Background of development of Cellular Phone GIS and previous research

This study on the utilization of Cellular Phone GIS in the education field is based on the development of mobile GIS cooperation between universities and Tokyo Gas Co., Ltd. (present TG Information Network Co., Ltd.) which started in 1997 to make GIS familiar as a tool to support education.

Mobile PC GIS (Figure 4-3) for geography education in high schools and universities was developed from 1997 to 1999, by improving the GIS that the gas company had produced for the maintenance of gas facilities (Itoh et al. 1998b, Okunuki et al. 2000).

For the development of mobile PC GIS, we focused on the usability of GIS. First, the application can be operated on a notebook computer with Windows because PCs with Windows are predominant worldwide. GIS on a notebook computer using the Windows operating system can be helpful to input data during fieldwork. Second, it is possible to import both vector and raster data. This function plays a role as a bridge between existing data or high-end GIS and mobile GIS, and assists users to use not only digital maps but also digital images of map. On these imported maps, users can record information as symbols, lines or polygons. Third, the integration of GIS with database or spreadsheet software such as Microsoft's ACCESS or EXCEL is also desirable to manage and analyze the collected data. Each user can customize the attribute data at his or her request with the database software. This customization broadens the potential of using mobile GIS. Furthermore, this integration of mobile GIS with database software gives users who are not accustomed to using GIS the ability to operate mobile GIS easily without extensive knowledge. Lastly, we added a function to input freehand notes and photographs with attributes about location. Cumulatively, these data and contextual notes offer a rich description of the study site and help to understand the current conditions in the field.

The research team conducted research on land use in a city with mobile PC GIS by university students. Most of the students did not have any knowledge of GIS but knew how to use the spreadsheet software. They did fieldwork and inputted information using mobile GIS and made charts using Excel.

After the initial development of mobile PC GIS as mentioned above, the research team then improved and miniaturized the mobile GIS application to permit it to operate on a PDA such as Palm OS or Windows CE (Figure 4-4).

Using cellular phones as an interface with GIS is an ultimate application of mobile GIS. Cellular phones are widely used in our daily lives as

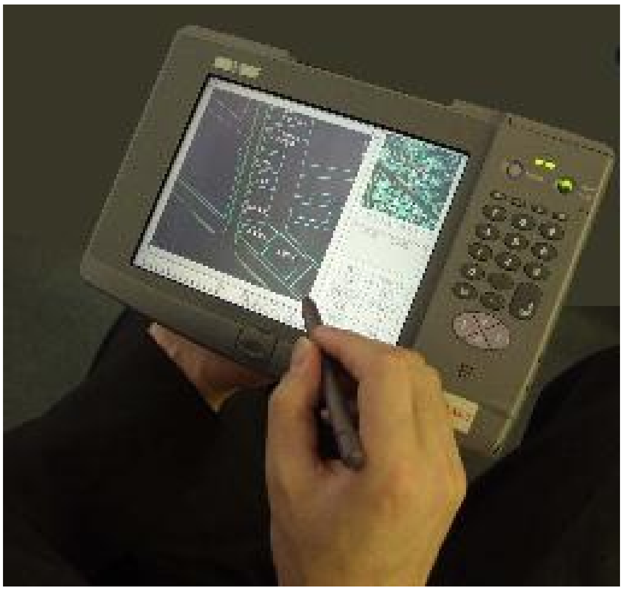


Figure 4-3 Mobile PC GIS

Figure 4-4 PDA GIS

communication tools and handheld terminal devices. As Figure 4-1 shows, the number of cellular phone bearers is 96 million. This means that almost 80% of the population has one or more cellular phones. Many cellular phone users use their phone not only to make calls but also to exchange text messages.

On the other hand, cellular phone technology itself has made spectacular progress. The diffusion of third-generation mobile phones since around 2004 has brought many changes in telecommunication. These innovations include light weight with a built-in camera, easier access to the Internet and simpler operation. And as it has become possible to run a large size Java-based application on a mobile phone, users can use the application by connecting to the Internet. Also, some problems arise when using mobile GIS on a PC. The weight and battery life of the computer affect the time because it cannot be used in the field without recharging. From this perspective, it is possible to say that the cellular phone is superior to the PC as a platform for GIS.

4.2.2 Outline of Cellular Phone GIS

The study on “Cellular Phone GIS” for educational use was started in 2004. “Cellular Phone GIS” collectively means the system including the GIS application for mobile phones (hereinafter called the Cell Phone GIS Application), an Internet browser-based viewer for PCs (hereinafter called a PC viewer), and the data server that connects them (Figure 4-5).

The Cell Phone GIS Application is a Java-based application for NTT docomo’s FOMA, a 3G cellular phone. This application accesses the database

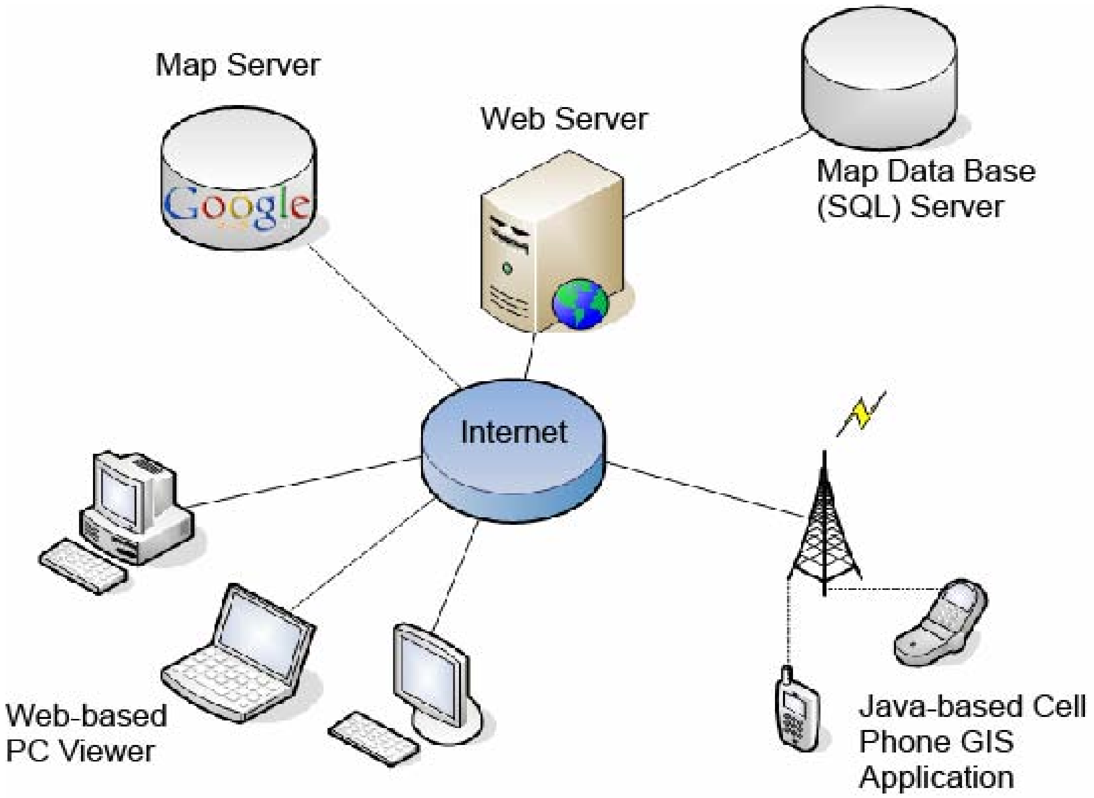


Figure 4-5 Structure of the Cellular Phone GIS System

server where the map data are stored and retrieves the necessary map data. Users always refer to the map while they input data and confirm the place on the map. Therefore, it is possible to go through the positions and attributes of all the data shown on the map of the area. Users can plot data on the map displayed on the mobile phone. The plotted data are displayed as icons on the map (Figure 4-6). The Cell Phone GIS Application is configurable in terms of alternatives for attributes in advance, so every investigator can input data in the same quality. In the case of land use surveys, users choose the attributes which are the anticipated type of land use and an icon to reflect each attribute is displayed.

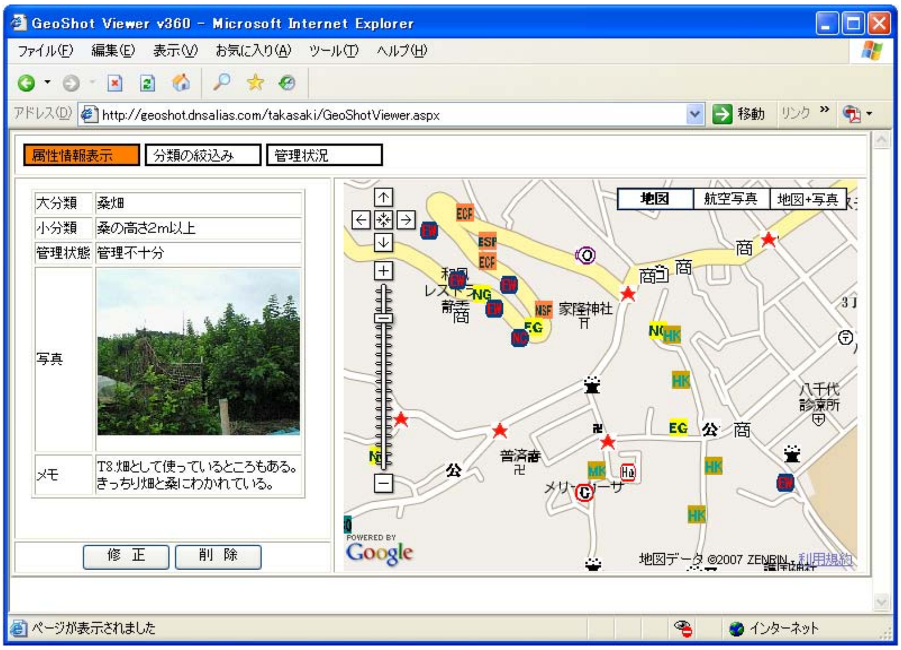
In addition to collecting data by alternatives, the user can take notes by inputting text. Also, this application can work with the built-in camera on the phone, so the user can add image data taken with the digital camera. All the data are saved with coordinates in the database server in which all the map data for the Cell Phone GIS Application are stored. These data can be read and edited by clicking on the icon which was generated by inputting the data.

The PC viewer on which the user can see the data input from the Cell Phone GIS Application on the PC is a web-based application using Google Maps. The PC viewer retrieves the data from the database server shared with the Cell Phone GIS Application and displays the data on Google Maps. From the PC viewer, the data can be viewed and edited [1)].

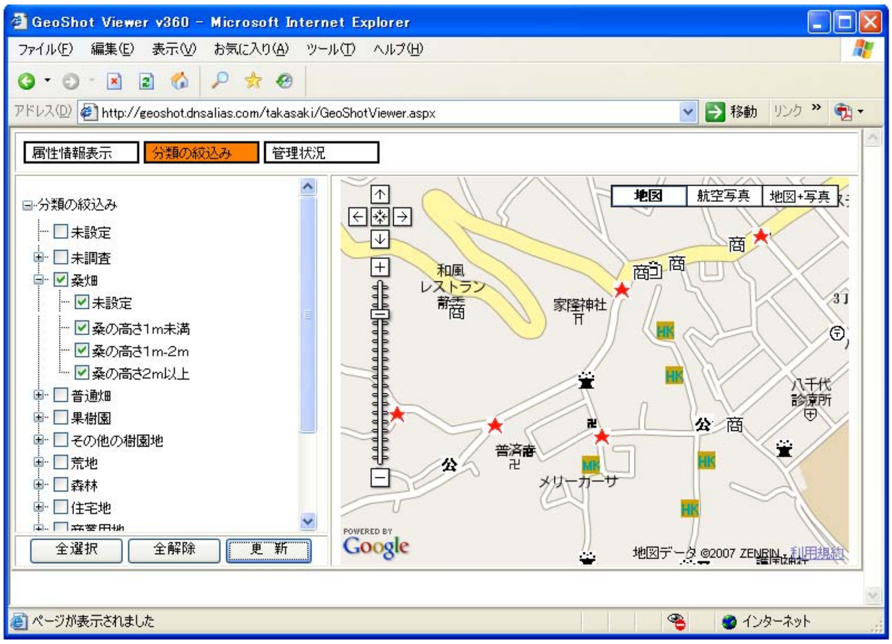
The left side of the PC viewer displays the attribute data and selected icon images (Figure 4-7a). When the “Display attribute data” tab is selected,

Figure 4-6 Display images of the Cell Phone GIS Application

(Upper secondary school version)



a) Displaying detailed data view



b) Selecting layer view display

Figure 4-7 Web-based GIS Viewer Application for PC using Google Maps (PC Viewer: Upper secondary school version) the attribute data can be modified. Also, it is possible to choose the layers which the user wants to show, so complicated combinations of layers are possible (Figure 4-7b).

The uniqueness of the Cell Phone GIS Application lies in the fact that users always refer to the map while they input data and confirm the place on the map. Therefore, it is possible to go through the positions and attributes of all the data shown on the map on the mobile phone display. Of course, the data can be monitored using the PC viewer at the same time.

Also, it is notable that the PC viewer only needs an environment with an Internet connection and Web browser and the functions do not depend on the type of OS or the PC's performance.

4.3 Experiment at university

4.3.1 How the experiment was conducted

The functions and effectiveness of Cellular Phone GIS were tested mainly in a land use survey in an urban area in November, 2004 (Itoh et al. 2005a and 2005b, Hayashi et al. 2005).

These studies were experiments to compare the ordinary method of research using printed maps, data collection forms and notes, and Cellular Phone GIS to see which students can collect data effectively. So the students surveyed the same land use objects in a shopping district in Kanazawa city by two different methods, the Cell Phone GIS Application and paper maps. (Figure 4-8).

The survey contents were the position of the place on the map, category of land/building use, frontage, number of stories, name of building, images using the built-in digital camera, name of the researcher, date of the research, and additional memoranda (Figure 4-9, 4-10).

The data input process of the survey using the Cell Phone GIS Application is as follows (Figure 4-11). The main functions of GIS on cellular phones are map display and data entry. To display the map of a place after login (Figure 4-9a), we have to select the address. In other words, first we choose a prefecture name, secondly a city name, and finally the name of the block or street (Figure 4-9b). The map can not only be panned or enlarged (Figure 4-9d) but also scrolled up or down. Data entry display is concerned with the information to be collected.

Users can collect various kinds of information such as land use in 8 major categories and 72 subcategories (Figure 4-9e). Major categories include office, store, restaurant, hotel, public, residential, open space and so on. The icons shown on the display in the Cell Phone GIS Application and on the PC viewer depend on the selection of category (Appendix 4-1). Users can also store other information such as the name of the building (Figure 4-9f) as well as pictures taken with the digital camera in the cellular phone (Figure 4-9g).

All the information is entered on the map which can be seen from any location in the Cellular Phone GIS Application (Figure 4-9h) or on the PC viewer via the Internet.

In a survey with paper maps, normally field notes are used to collect data. In this comparative study, a data collection form was made in advance and used (Figure 4-10). This study compared the effectiveness of surveys using

Figure 4-8 Experiment using the Cell Phone GIS Application (2004)

a) Login b) Selection of place name c) Map of selected place d) Selection of map scale

e) Selection of land use category f) Entry form for other information g) Digital photo h) Map stored with information

Figure 4-9 Display images of the Cell Phone GIS Application (University version)

町　　　　　　　　丁目／番地

番号	大分類	小分類
間口 ｃｍ	奥行 ｃｍ	階数 階建
名称		
メモ１	メモ２	メモ３
調査年月日 平成　　年　　月　　日	調査者氏名	

Figure 4-10 Data collection form using paper maps (2004)

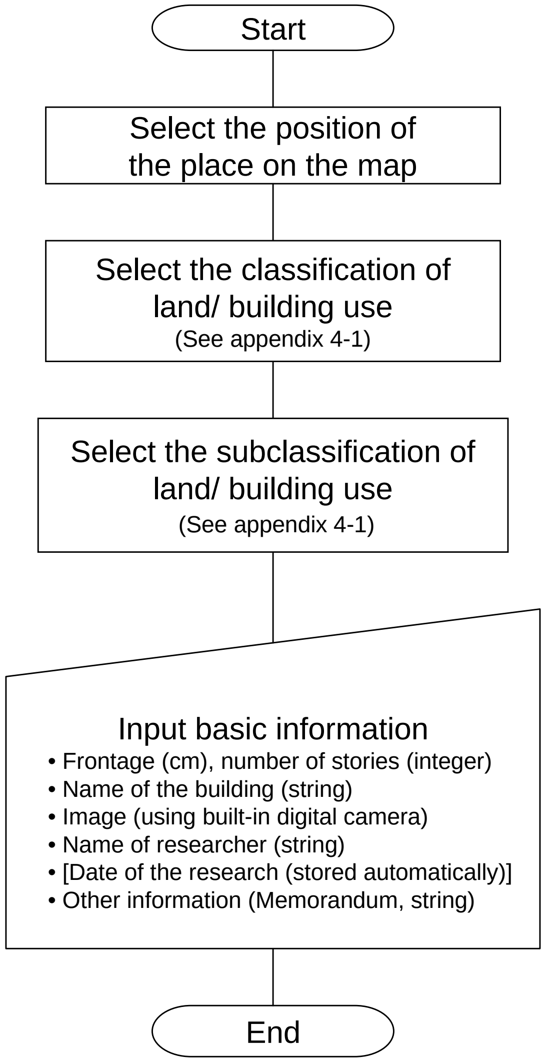


Figure 4-11 Data input process of land use survey with Cell Phone GIS Application (University version)

Cellular Phone GIS and using paper maps. The experiment was conducted in a university class focused on geographical fieldwork. Each student experienced two types of fieldwork. One was a conventional survey using paper maps and field notes and the other depended on Cellular Phone GIS.

As to the two methods of the survey, we measured the time needed to collect the same information in the same region.

4.3.2 Results of the experiment

The time required to input 104 records by the 11 students who participated in the survey was calculated. The survey using paper maps required 2.7 minutes to collect the data at each point. The Cell Phone GIS Application needed 3.0 minutes. Although the time needed using paper maps was a bit shorter than the Cell Phone GIS Application, it can be said that the efficiency was almost the same.

The conventional method using paper maps was designed to achieve as effective results as possible. If the students did not use the data collection form but field notes and paper maps, efficiency might be reduced. Also, it must be remembered that only the results of the time required to collect (input) the data are compared. In the survey using paper maps, inputting and counting data were required after the fieldwork. Conversely, in the case of Cellular Phone GIS, the user input the data to the database on the server in the field, so they did not need to do it again after coming back. Also, image data taken with the built-in digital camera on the mobile phone and the geo-coordinates of each record were recorded by the Cell Phone GIS

Application. These survey items were not included in the survey using paper maps. Consequently, Cellular Phone GIS is higher in efficiency.

After making improvements to the Cell Phone GIS Application, the author conducted a comparative experiment of the original version and the new version of the Cell Phone GIS Application. This survey measured the time required to input data on the same 10 search points using two different versions of the application. The entry speed of the old version was 1 minute 45 seconds and the new version was 1 minute 24 seconds without loss of time. Compared to the old version, 21 seconds were saved with the new version (Table 4-1).

If the working efficiency using paper maps is taken as 100, efficiency using the old version of the Cell Phone GIS Application was 90. Because the survey content and conditions were different, the survey using paper maps and the Cell Phone GIS Application and the survey using the old and new versions of the application cannot be compared. However, if the working efficiency using paper maps is converted to 100, the new version of the Cell Phone GIS Application becomes 112.5. Therefore, even if we only look at data collection in the field, the survey using Cellular Phone GIS is considered more efficient.

4.3.3 Effectiveness of Cellular Phone GIS from surveys by university students

The other thing worthy of special mention is that, because most of the students were familiar with cellular phones, they could easily use Cellular

Table 4-1 Comparison of efficiency between old version and improved version of Cell Phone GIS Application (2005)

a) Improved version of Cell Phone GIS Application

Research point	Researcher	Start time	Finish time	Time required	Time loss	Actual time required	No. of research points
South side of the street	A	9:57:20	10:14:20	0:17:00	0:04:35	0:12:25	10
	B	10:18:45	10:31:05	0:12:20	0:00:25	0:11:55	10
	C	10:43:00	10:58:00	0:15:00	0:01:05	0:13:55	10
	Subtotal				Average	0:12:45	10
North side of the street	D	9:48:00	10:03:00	0:15:00	0:00:00	0:15:00	10
	E	10:24:15	10:41:00	0:16:45	0:00:10	0:16:35	10
	Subtotal				Average	0:15:48	10
Total					Total required time	1:09:50	
					Total research points		50
					Actual time required/ point	0:01:24	

b) Older version of Cell Phone GIS Application

Research point	researcher	Start time	Finish time	Time required	Time loss	Actual time required	No. of research points
South side of the street	A	10:43:00	10:57:25	0:14:25	0:00:00	0:14:25	10
	B	9:57:20	10:16:05	0:18:45	0:03:25	0:15:20	10
	C	10:18:45	10:44:50	0:26:05	0:06:13	0:19:52	10
	Subtotal				Average	0:16:32	10
North side of the street	D	10:53:00	11:12:00	0:19:00	0:00:00	0:19:00	10
	E	9:48:00	10:22:00	0:34:00	0:14:42	0:19:18	10
	Subtotal				Average	0:19:09	10
Total					Total required time	1:27:55	
					Total research points		50
					Actual time required/ point	0:01:45	

(Source: Author's survey)

Phone GIS without a detailed explanation of how to use it. If they used GIS on a PC for the first time, they would need a long time to learn how to use it. This is meaningful not only for students but also for teachers, because they do not always have enough time in class for training.

After the survey, the students answered that they were more interested in the survey using Cellular Phone GIS than the survey using paper maps.

Furthermore, users reload the map on the application during the survey, and then the application retrieves the data from the server. Therefore, users can see that the data on the map are updated immediately. If several users are using the application at the same time, the users can see all the information input by everybody using this tool and can see the overall progress of the work. Such real-time data-sharing can enhance the learning effect. Therefore, it could be said that the effectiveness of Cellular Phone GIS use in education will be high.

4.4. Practice in using Cellular Phone GIS in lower secondary school

4.4.1 Outline of practice in lower secondary school

The next phase of the study was practice in using Cellular Phone GIS and evaluation of its effectiveness in secondary education. Since the urban survey using Cellular Phone GIS by university students in Kanazawa city in 2004 clarified some problems in usability, Cellular Phone GIS was improved in respect of scale switching and input interface for use by classes in lower and upper secondary schools.

Practice in lower secondary school was conducted at Tamamura Minami

Table 4-2 Lesson plan for “Elective social studies” (10 class periods)

Theme: “Research the secrets of the new/ old shopping area in Tamamura town with GIS”

	Aim and content of lesson
Introduction	1. Orientation of the route, “Elective social studies”(1 class period) 2. Setting the goal of the unit using Google Earth (1 class period) ① Set the goal of the unit (20 min) ② Try to use Google Earth (30 min.) 3. Preparation for fieldwork 1 (1 class period) ① Make a hypothesis of the fieldwork (30 min) ② Learn ‘Netiquette’ (20 min) 4. Preparation for fieldwork 1 (1 class period) ① Try to use the Cell Phone GIS Application
Fieldwork	5. Fieldwork (2 class periods) ・ Do fieldwork in groups in the shopping area 6. Combining results from fieldwork (2 class periods) ・ Combine results from the fieldwork using the PC viewer
Presentation	7. Making a presentation about the results of the fieldwork (2 class periods) ・ Craft a presentation with Google Maps and presentation software.(1 class period) ・ Presentation (1 class period)

Junior High School in Tamamura town, Gunma prefecture. In elective social studies classes for 2nd grade students, a survey of the neighborhood area was conducted in June 2007 (Table 4-2, Appendix 4-2, 4-3, 4-4, 4-5, 4-6, 4-7).

The survey was conducted of the area of historic streets in the original center of the town that flourished from the Edo period through the Showa era and an area along the new road that is being developed where new suburban shopping centers and other shops have opened. The purpose of the survey was to find differences in the characteristics of the areas from data collected in the fieldwork.

4.4.2 Proceedings of classes using Cellular Phone GIS

1) Explanation of Cellular Phone GIS and learning how to operate it

The anticipated problems in practice for lower secondary school students are the operation of the applications in Cellular Phone GIS and the quality of the data collected by the students.

The Cell Phone GIS Application is a Java-based application running on the mobile phone and is designed for any model of mobile phone. The way of operating the application is common to other functions on the phone such as applications for email or games. Operation itself will be easy for cellular phone users. Although the penetration rate of mobile phones among lower secondary school students is 57.6% (Cabinet Office, 2007), students deemed it necessary to learn how to operate the application and acquire cell phone literacy in advance.

Additionally, the point of the survey was whether students can plot data on the target building on the map precisely. Map reading skills and data input skills were strongly required of the students.

First of all, the students input dummy data on the objects using the Cell Phone GIS Application as practice. At that time, the students were in the classroom and entered the data on the names of the buildings to be researched. The input data were modified in the fieldwork. Here, all the research objects fell into the same category of land use. Therefore, the displayed icons were the same until the fieldwork was conducted. The idea was to enable finished objects or unfinished objects to be recognized easily, because the design of the icon was defined by the category of land use and would be changed when new information was entered. Such real-time data-sharing is one of the benefits of introducing mobile GIS.

In the class, the students entered data on the shapes of the buildings displayed in the Cellular Phone GIS Application by looking at detailed paper maps of the study area (Figure 4-12). Through the work, the students were expected to become accustomed to operation of the application and acquire a spatial image of the survey area.

2) Practice using Cellular Phone GIS in fieldwork

The aim of this practice was to examine the effectiveness of the Cellular Phone GIS itself.

Students were divided into groups of 1 or 2 people and were sent to their research area to collect data on the buildings which had been entered in advance (Figure 4-13).

On the hypothesis that the scenery in the research area would differ

Figure 4-12 Practicing the Cell Phone GIS Application in the classroom (2007)

Figure 4-13 Fieldwork using the Cell Phone GIS Application (2007)

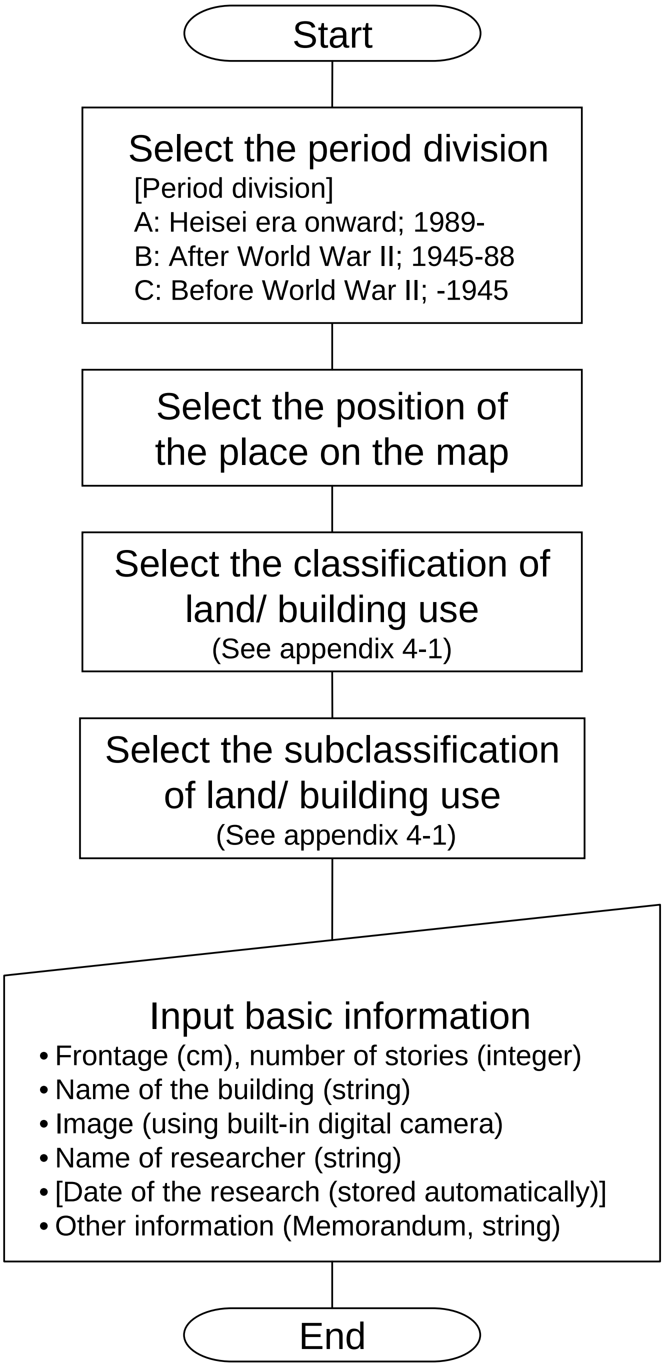


Figure 4-14 Data input process of land use survey with Cell Phone GIS Application (Lower secondary school version)

according to the age of the buildings there, three periods were set in the survey. The periods are A. Heisei era onward, B. Showa after World War II, and C. before World War II. The PC viewer was modified to show data in layers in these age periods. This arrangement was added so that students could know the period in which the building was built when they looked at the data on the PC viewer.

Students chose the land use of the object from the list of land use categories, and in addition, entered the year of construction, number of stories, images taken by mobile phone and information obtained by interviews or comments such as their impressions of the object (Figure 4-14).

3) Observation using PC viewer in classroom

Data input from the Cell Phone GIS Application can be viewed on the PC viewer using Google Maps. The uniqueness of the PC viewer is that the web-based application uses maps from Google Maps as the base map. And schools do not need to install any special software. Every school with an Internet connection and computers with a web browser can use the PC viewer. Google Maps is a free web mapping service and provides views of maps, satellite images, hybrid views and so on. The icons for the Cell Phone GIS Application can be used in the PC viewer (Figure 4-15). As mentioned above, it is possible to switch the display of the layers of the period divisions of the building entered in the fieldwork. This function can show the distribution of buildings by period of construction clearly.

The PC viewer can visualize the data collected by the students themselves. Using the PC viewer, students seemed to understand the transition of the

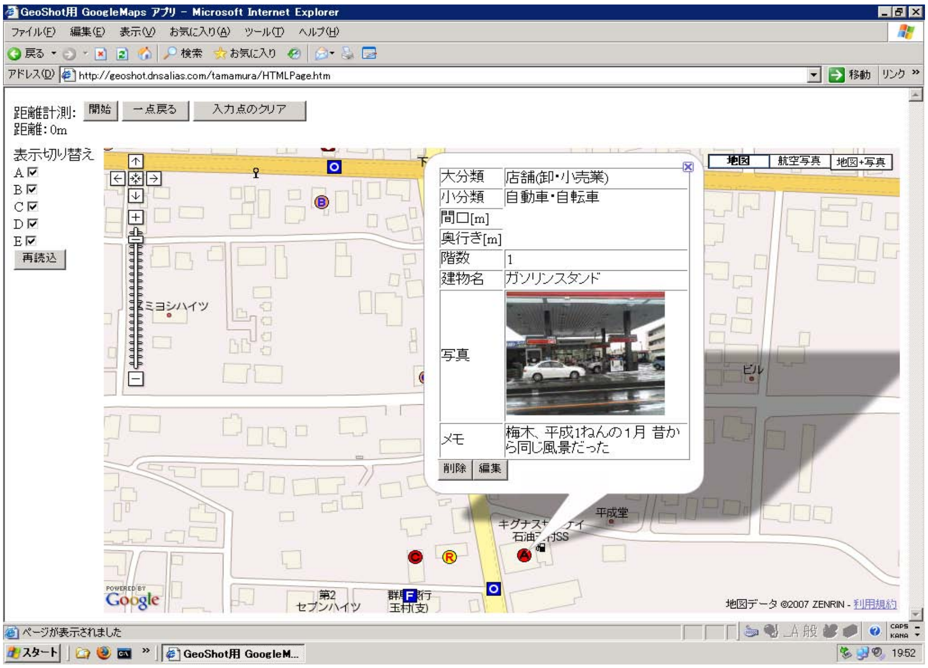


Figure 4-15 Web-based GIS Viewer Application for PC using Google Maps (PC Viewer: Lower secondary school version)

commercial area and the movement of the center of the town across the ages. Evaluating students' observations or opinions from the fieldwork survey, the original aim of the classes was achieved using Cellular Phone GIS.

4.4.3 Effectiveness of using Cellular Phone GIS and issues in lower secondary school

On the day of the fieldwork it rained. If this survey had been conducted with paper maps and notebooks, it would have been difficult to accomplish the trial. However, use of Cellular Phone GIS reduced the impact of the weather. Also, the students did not need to do any extra work after the fieldwork. If the recording media had been divided into paper maps, notebooks and cameras, they would have needed to integrate the data. The classes using Cellular Phone GIS could move to the next step smoothly. The practice in lower secondary school also showed the expected effectiveness of this system.

Moreover, the author conducted a questionnaire survey. 7 of the 8 students who participated in the survey responded. 6 of the 7 had learned how to read maps in elementary school. About half of the students (3) had mobile phones and used email, the Internet and applications daily. Although the students who used mobile phones considered operation of the Cell Phone GIS Application easy, the other students seemed to feel it was difficult.

5 of the 7 students answered that they enjoyed the survey. Some of them said that they discovered many things that they had not known before. Also, one student enjoyed finding the research objects input on the map in the real

world. A few students said that it was difficult to confirm whether an object on the map was the same object in the real world, or that the survey itself was hard.

During the fieldwork, sometimes the students found that the points of an object had been input wrongly in the previous class and they needed to modify the data. But some students who relied on text data on the map and believed the data were correct did not realize the errors and tried to continue to enter other data, because they did not see the map as reflecting the real world. As seen in Chapter 3, lower secondary school students tend to look at the name of the building primarily. This is likely to happen. Also, the map data in the Cell Phone GIS Application consisted of simple maps with the shape of the roads and buildings without any text data. Students rated the maps in the Cell Phone GIS Application 2.86 on average on a scale of 5 for readability. As for the usability of the application, the score was also 2.86, the same as the evaluation of the maps. These scores are not high. The results are assumed to derive from students' unfamiliarity with mobile phones, lack of development of map reading skills and the quality of the maps and the application itself.

Maps used in the Cell Phone GIS Application need to be more readable and include more information to support users' map reading skills, and the application itself also needs to be improved in terms of usability. In this experiment, the problem of Cellular Phone GIS was the inability to edit data from the PC viewer because the info window function, Google Maps API, was used. Therefore, users input and edited data using the Cell Phone GIS

Application and the PC viewer had the function purely of a viewer. The PC viewer was inconvenient in this respect. For the next phase, Cellular Phone GIS needed to be improved.

4.5 Practice using Cellular Phone GIS in upper secondary school

4.5.1 Outline of practice in upper secondary school

1) Outline of the series of classes

After making changes and improvements to the maps in the Cell Phone GIS Application and to the PC viewer based on the experiments in the university and lower secondary school, practice using Cellular Phone GIS was conducted in upper secondary school.

The classes using Cellular Phone GIS in upper secondary school were implemented in the unit, “research in neighborhood,” in a “Geography B” elective course at Takasaki High School, Gunma prefecture, in September 2007. 12 students in the second grade participated in this experiment.

Gunma prefecture used to be famous for sericulture and mulberry fields covered a wide expanse of the prefecture. In 1965, 61% of farmers in the prefecture grew mulberry trees, so the acreage under mulberry cultivation was 23,117ha (Nihon chishi kenkyujo ed. 1968). Nowadays, sericulture has declined because of urbanization and aging of the sericulturists, so the acreage under mulberry cultivation in the prefecture was 1,100ha in 2005 (Kanto Regional Agricultural Administration Office, 2005). In this research, students compared topographic maps showing the area near the school between around 1975 and 2000 and found places where land use had changed

Table 4-3 Teaching plan for “Fieldwork using Cellular Phone GIS” for geography classes in upper secondary school

Lesson	Content of lessons
1	Students read maps to find the changes in land use around the high school between 1975 and 2000 using topographical maps and aerial photos on the Web GIS system.
2	Teacher explains how to operate the Cell Phone GIS Application. Students use it and understand the operation of the application. Students find the study area with the PC Viewer and decide the route to research. Students are divided into 6 pairs of 2 persons. Teacher gives instructions on the fieldwork. Teacher suggests students see the study area before doing the fieldwork, if possible, so as not to get lost.
3	Each pair moves to their study area by bicycle. One has a mobile phone and confirms the research points and inputs the data on land use. The other observes the area.
4	Each pair makes a presentation on the results of the fieldwork using the PC Viewer. They report on the actual conditions and characteristics of their own study area.
5	Based on the presentations, the students consider the characteristics of the changes in land use around the high school and consider agricultural problems in Gunma prefecture and Japan.

from mulberry fields during the 25 years. Then they surveyed the land use of former mulberry fields at the time of the survey in September, 2007.

The content of each class was as follows. In the 1st period, as mentioned above, using WebGIS[2)] the students compared old and new topographic maps from around 1975 and 2000 and found changes in land use. In the following 2nd period, the students used the Cellular Phone GIS Application and PC viewer in the classroom and learned how to operate them and confirmed the route of the survey. In the 3rd period, the students conducted fieldwork with the Cellular Phone GIS Application. In the 4th period, the students reported the collected data in each surveyed area using the PC viewer and shared the information with the other students. Then in the 5th period, each student considered the actual condition of the mulberry fields and the tendencies in distribution in the surveyed area using the function of choosing the layers to display on the PC viewer (Table 4-3).

2) Preparation to introduce Cellular Phone GIS

The maps used in the Cell Phone GIS Application were 1:25,000 digital maps (2003) issued by the Geographic Survey Institute. The maps include information on roads, railways, rivers, borders of municipalities, place names and public facilities. But the scale of the maps is small, so the maps are less detailed. This fieldwork was conducted at micro-level to see the condition of the fields in a residential area. Digital maps of this scale do not include data on boundaries of houses, and users find it hard to recognize land use in fields in mountainous areas. Furthermore, when student users read maps, they have a tendency to depend on text information such as the names of places or buildings rather than the shape of the roads or buildings (Yuda et al. 2007), so other data that is not included in digital maps is needed to support map reading when students go out into the field.

To add supplemental information, text data and photo images of some points to act as landmarks and survey points were added. These image data were expected to help students to recognize where they are on the map and to find their destination accurately, so they were added arbitrarily. Survey points were indicated by the $\boxed{?}$ icon so that users could find unvisited points, see the progress of the research when they added the attribute data that changed the design of the icon as the type of data, and feel a sense of accomplishment.

3) Usage of Cellular Phone GIS

The study area of the fieldwork, within 5 km from school, was divided into 6 sub-areas. Each group collected data on 7 to 10 points in each sub-area.

In the survey, the students collected data using the Cell Phone GIS Application as follows: type of land use, presence of mulberry fields, type of crops or trees, and condition of the mulberry fields in the event of finding them at the point. In the case of agricultural land use, waste land or forest, students chose the condition of the survey point. In addition, they recorded notes and memos of interviews and took images with the mobile phone camera (Figure 4-16).

The students went to find the research points in the Cellular Phone GIS Application, then input the data on land use and mulberry fields at the

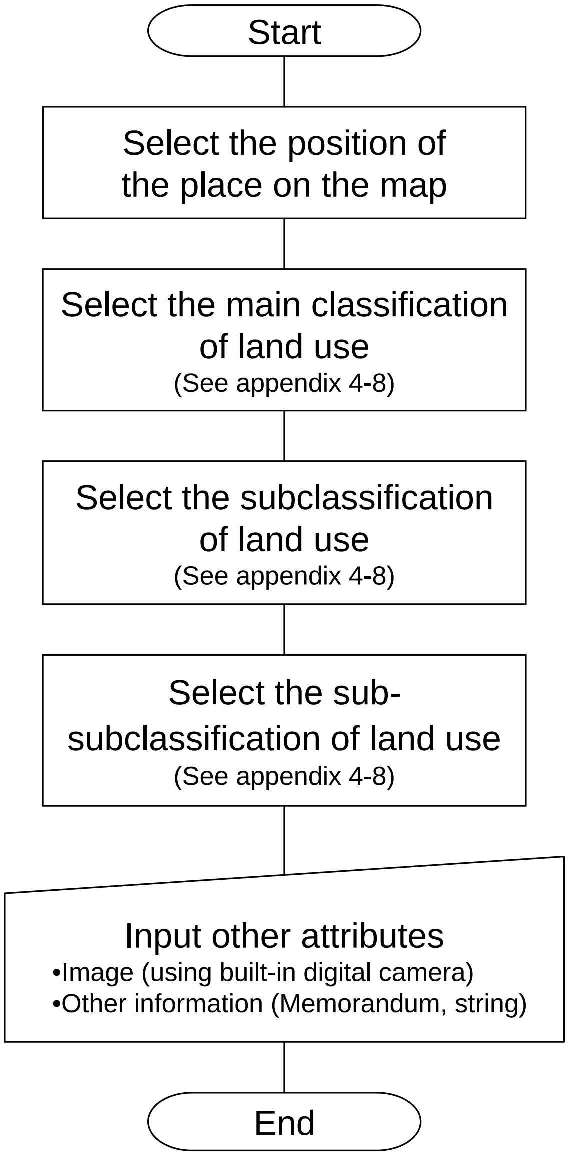


Figure 4-16 Data input process of land use survey with Cell Phone GIS Application (Upper secondary school version)

Figure 4-17 Fieldwork with Cell Phone GIS Application (2007)

Figure4-18 Interviewing local people in the fieldwork (2007)

Figure 4-19 Students examine the survey results using PC Viewer (2007)

location (Figure 4-17). Also, they interviewed local people about the area and learned more about the changing face of the mulberry fields (Figure 4-18).

After the fieldwork, the next lesson was held in the classroom. Displaying the maps and collected data with the PC viewer, each group reported what they had found and all the students shared the information on the conditions at the research points and the mulberry fields there. Then, in the next class, the students considered the distribution and tendencies in land use in the study area from many points of view such as the geological, historical and economical aspects (Figure 4-19).

4.5.2 Student's evaluation of introducing Cellular Phone GIS into fieldwork

The author conducted a questionnaire survey on Cellular Phone GIS and fieldwork. From these results, we can see the effectiveness of the Cellular Phone GIS in the fieldwork.

1) Usability of the Cell Phone GIS Application

The students' evaluation of the Cell Phone GIS Application can be explained by their mobile environment and map study experience.

25% of the students answered that operation of the Cell Phone GIS Application was very easy, 58.3% of them answered that it was easy, and the other students said neutral. No student said it was difficult to operate. On a 5-point scale, they rated the usability of the Cell Phone GIS Application 4.08 on average. Compared to the lower secondary school students whose score was 2.86, the upper secondary school students' score is 1.22 points higher.

As the application was improved after the practice in the lower secondary school, it was anticipated that the result of usability would be better. However, one of the main reasons why the students could use the application on the cellular phone was the popularity of mobile phones among the students themselves. 11 out of the 12 students have cellular phones. All the students who have a mobile phone use the email function and more than 70% of the students use their mobile phone for making calls and browsing the Internet. And about half of the students also use games and other applications (Table 4-4).

The operating procedures for the Cell Phone GIS Application are common to the operation procedures for email, web browser and applications on mobile phones. Students in upper secondary school have already mastered the use of the mobile phone. For that reason, it is assumed that for the students the use of the Cell Phone GIS Application will be rather easy.

To use GIS, map reading skills are necessary. More than 90% of the students in the survey answered that they had learnt how to read maps. About 70% had learnt in lower secondary school, and about 30 % had learnt in elementary school and upper secondary school (Table 4-5).

75% of the students who participated in the survey said that they could understand paper maps very well or well. Regarding the maps in the Cell Phone GIS Application, the result was almost the same (Figure 4-20). On a 5-point scale, they rated the readability of the maps in the Cell Phone GIS Application 3.83 on average. Compared to the lower secondary school students, the score was 0.97 points higher.

Table 4-4 Mobile phone usage among students

Functions used	(%)
E-mail	100.0
Internet	72.7
Call	72.7
Applications	54.5
Digital camera	9.1
Music player	9.1

(n=12, multiple answers)

Table 4-5 Period of map Study

	(%)
Elementary school	27.3
Lower secondary school	72.7
Upper secondary school	27.3
N.A.	27.3

(n=11, multiple answers)

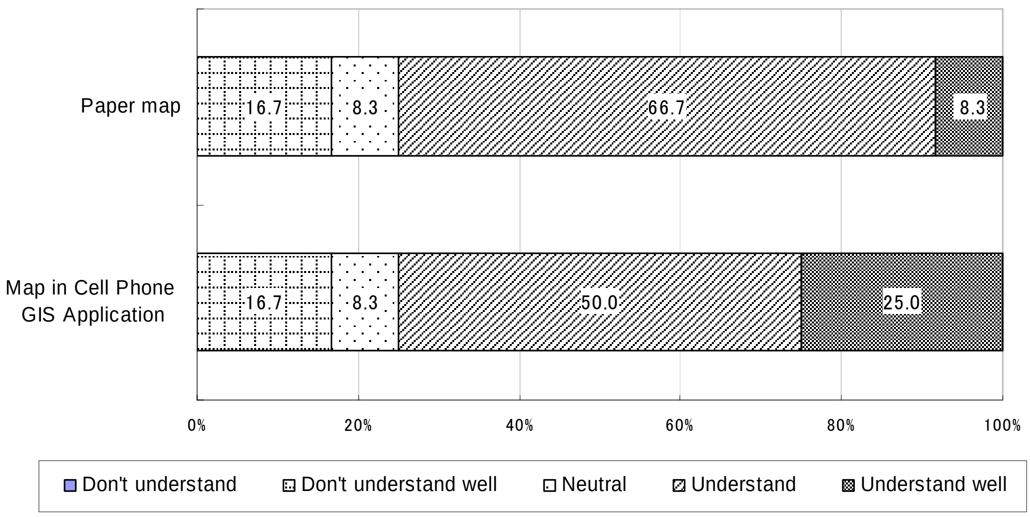


Figure 4-20 Students' literacy in paper maps and digital maps in the Cell Phone GIS Application

The upper secondary school students not only use mobile phones but had also learnt how to read maps. Most of them answered that they could understand what was drawn on the map. From these results, it can be said that introducing the Cell Phone GIS Application into the fieldwork posed almost no problem.

2) Impressions of the fieldwork with Cellular Phone GIS

'Geography B' in which the practice was conducted is an elective subject. Students who like geography take this course. Before the practice, their interest in fieldwork seemed to be a mixture of expectation and anxiety (Figure 4-21). Students with positive opinions expected to go out and survey by themselves and were interested in the Cell Phone GIS Application. Students who did not expect much did not know what they would have to do in the survey and thought it would be hard.

The students' image of the Cell Phone GIS Application before use showed the same tendency as their image of the fieldwork above. Before use, 75% of the students had an 'advanced' image and half of the students felt it would be 'interesting.' On the other hand, some of the students answered that they thought it would be 'hard to understand,' 'complicated' or 'boring' (Figure 4-22).

It is natural to feel anxiety about something unknown and to have a negative image of it. But many of the students seemed to feel interested in the new tool and have expectations of it.

The students' impressions after the fieldwork were not so bad. More than 80% of the students answered that they 'enjoyed very much' or 'enjoyed' the

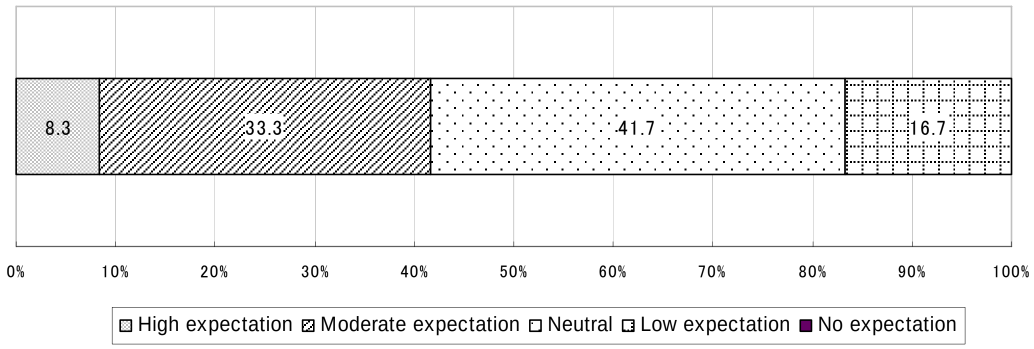


Figure 4-21 Degree of expectation of the fieldwork

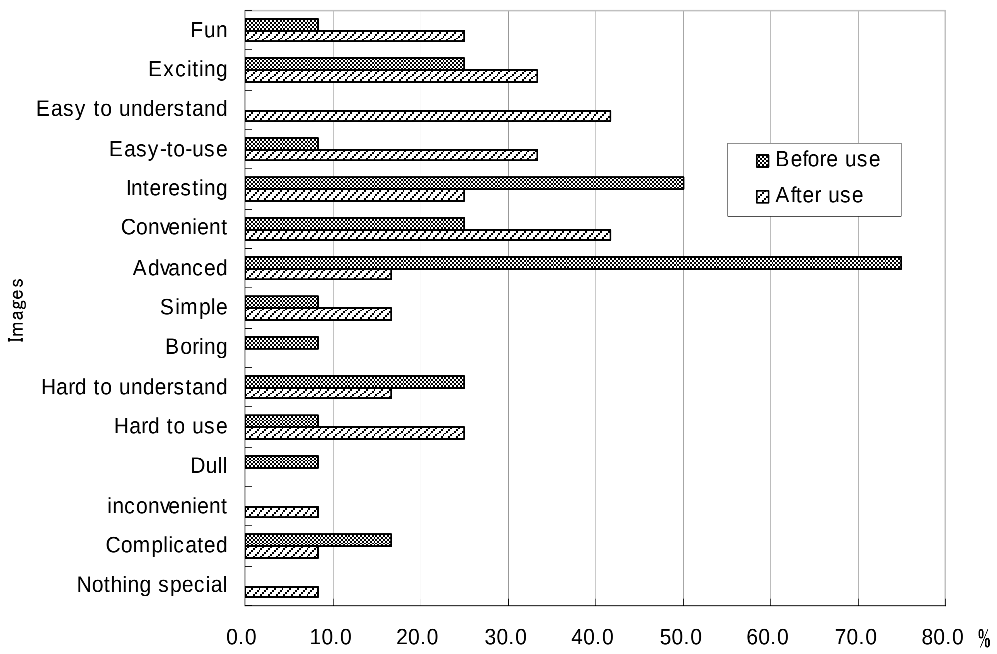


Figure 4-22 Image of Cell Phone GIS Application before and after Use

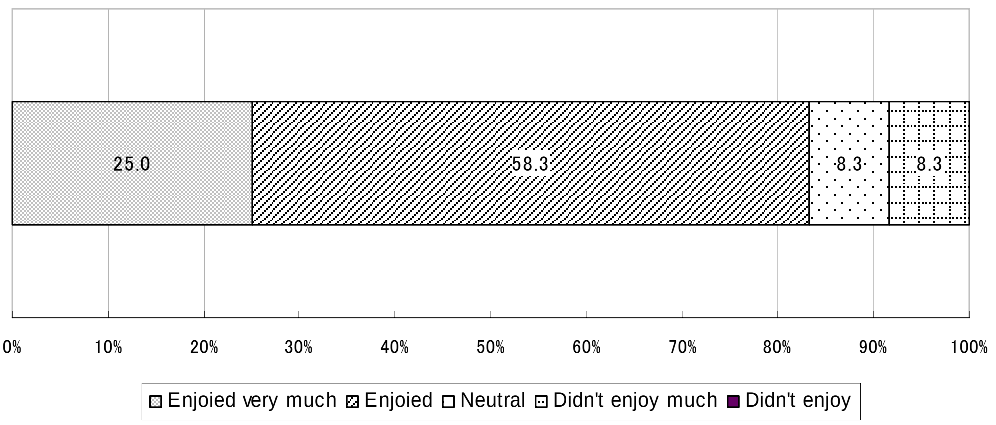


Figure 4-23 Impressions of the Fieldwork

fieldwork (Figure 4-23). The reasons included seeing the fun of the fieldwork, like a game, in finding the survey points and acquiring new knowledge about their neighborhood through observing and interviewing.

After using the Cell Phone GIS Application, the students did not have such an 'advanced' image any more. On the other hand, they had positive images such as 'convenient,' 'easy to understand,' 'interesting' and 'easy to use.' Students who had had a negative image before use also had a good image after use.

It can be said that most of the impressions of the fieldwork are related to the characteristics of the fieldwork itself. But using Cellular Phone GIS in fieldwork can be valued for making the fieldwork attractive.

At the end of the series of classes with the fieldwork, 66.7% of the students thought that this fieldwork did not seem to be directly linked to the university entrance examinations. On the other hand, more than half of them were of the opinion that the experience in conducting surveys and making observations from various perspectives might be indirectly linked to the entrance exams and making a presentation on their findings in the fieldwork would be a necessary skill in the future.

Through these experiences, more than half of the students came to have a better image of geography and were interested in the subject more. Furthermore, three-quarters of the students said they wanted to continue to study geography.

Overall, students' satisfaction with the classes in fieldwork incorporating Cellular Phone GIS was high, and students seemed to actively participate in the survey. Also, it is interesting that they saw the learning effects acquired from the process of research and observation from a future perspective.

4.5.3 Benefits of introducing Cellular Phone GIS and possibilities of its utilization in upper secondary school

Cellular Phone GIS revolutionizes the style of fieldwork classes. The tools for gathering information which can be separated into maps, notebooks, writing tools and cameras are integrated into one mobile phone. Surveys conducted with the Cell Phone GIS Application are almost unaffected by the weather (Yuda et al. 2007). Users can see the data that have been input by themselves and others in the Cell Phone GIS Application. Furthermore, all the attribute data can be input at one time. Cellular Phone GIS does not require the series of work required in conventional field surveys such as inputting various and discretely collected data using paper maps, notebooks and digital cameras to the PC after coming back to school. One reason why teachers do not think of conducting outdoor surveys in class is that fieldwork requires time. But the characteristics of Cellular Phone GIS enable the fieldwork to be completed in lesson hours. This is precisely the effectiveness of the introduction of Cellular Phone GIS.

One of the main advantages of introducing Cellular Phone GIS, as seen from the viewpoint of the students, is that they can participate in field surveys with low stress. They are familiar with mobile phones, so they can operate the GIS easily. They just need to focus on entering data with a familiar tool during the fieldwork and then do not need to do almost anything else. Cellular Phone GIS provides a school environment where they can concentrate on studying.

From the point of view of the teachers who design the course, they can save a lot of time by using Cellular Phone GIS. The operation of the mobile phone itself hardly needs to be explained to the students. It is possible to complete the data input during the fieldwork, therefore the teachers do not need to arrange extra lesson hours or ask students to stay after school. Furthermore, they have time to think about how to develop ideas for the next step of the class.

One school had experience in conducting field surveys using GIS software for a PC or WebGIS (Uchida 2007). But such fieldwork had to be conducted after school or during the school holidays. In addition, the teacher and students needed to input the data collected during the survey to the PC after coming back to school. Furthermore, lesson hours for acquiring the skills to operate the software were required. Because lesson hours are limited, many of the GIS functions such as making maps, which students like doing, or analyzing the data could not be used in class. As a result, it was hard for the students to benefit from the field survey. In other words, although originally the aim was to introduce GIS as a convenient tool into school education, GIS itself created an environment where not only the teachers but also the students were unable to use the original functions of GIS in class.

Introducing GIS required much time and shortened the teaching hours. Also, it is possible that data entry work after the outdoor survey demotivated the students. It is necessary not only when using GIS but also in conventional fieldwork to put data together and observe the results.

Cellular Phone GIS can be expected to solve these issues arising from introducing GIS. As mentioned above, almost all students in upper secondary school have mobile phones which are the core of the system, and the tool is widely accepted. So it is expected that the Cell Phone GIS Application will be easily accepted by upper secondary school students. Regarding the PC viewer, only an Internet connection and web browser are required, so it should be possible to introduce it into schools.

4.6 Conclusion

In this chapter, the author developed ‘Cellular Phone GIS’ and evaluated its effectiveness in lower and upper secondary schools and in university.

First of all, an experiment in land use surveys using the prototype of the Cell Phone GIS Application was conducted to see the effectiveness and usability of the tool. The results proved that the efficiency of Cellular Phone GIS was higher than conventional surveys with paper maps.

In lower secondary school, Cellular Phone GIS was used in fieldwork to research the neighboring area of the school. Because students used the Cell Phone GIS Application in the field survey, they could finish inputting the data during the fieldwork even though it rained on that day. This trial proved that the Cell Phone GIS Application can be used in all weather conditions.

In the practice in the lower secondary school, some of the students had problems reading the map in the Cell Phone GIS Application. So for the practice in the upper secondary school, text or image data were added on the base map to assist students in reading the map. Also, it was possible to edit the data on the PC viewer.

In the upper secondary school, the students conducted a land use survey. The evaluation of Cellular Phone GIS here was better than the evaluation in the lower secondary school. Some of the students thought that the experience of collecting data by themselves and examining them using GIS would be useful for the future. This practice showed that fieldwork with Cellular Phone GIS produced an educational benefit.

It can be said that Cellular Phone GIS combining the Cell Phone GIS Application and PC viewer makes it possible to conduct fieldwork and examine the results of the survey while keeping students’ motivation high and making maximum use of the limited time and school facilities in question.

There is no doubt that the practices conducted here indicate that Cellular Phone GIS could be used in school education. When actually considering the introduction of Cellular Phone GIS, this tool would be suitable for upper secondary school or university based on students’ skills in operating mobile phones and map reading skills.

But Cellular Phone GIS remains at the developmental stage. Usability of the Cell Phone GIS Application and readability of the base maps on the application, in particular, are still not good enough to be a tool for every student, even though the application and maps were modified for the upper secondary school students based on the opinions of the lower secondary school students. Mobile devices are being equipped with various advanced functions at a rapid pace. Furthermore, the network environment is changing and the ubiquitous society is coming. Improvement of Cellular Phone GIS should take place against the background of considering the rapid development of mobile phones and the network environment and the characteristics, needs and views of students and teachers as users.

Notes

1) Only the PC viewer for upper secondary school enabled the data to be edited as well as viewed. There were some opinions that users wanted to edit data not only with the Cell Phone GIS Application but from the PC viewer.

2) In 2004 and 2005 Takasaki High School conducted classes using WebGIS developed in a project by the Ministry of National Land and Transportation from 2003 to 2005 (Uchida 2007). This system was used in the first practice.

References

Akimoto, H. 1996. GIS (chiri joho shisutemu) to koko chiri kyoiku (GIS [Geographic Information System] and geography education in high school). *Shin chiri (New Geography)*, 44-3, 24-32.

Baker, T. R. and White S. H. 2003. The effects of G.I.S. on students' attitudes, self-efficacy, and achievement in middle school science classrooms. *Journal of Geography*, 102, 243-254..

Cabinet office 1999. *Mireniamu purojekuto (atarashii sennenki purojekuto) ni tsuite: naikaku soridaijin kettei (About the Millennium project decision by Prime Minister)*. http://www.kantei.go.jp/jp/mille/991222 millpro.pdf

Cabinet office 2007. *Dai 5-kai johoka to seishonen ni kansuru ishiki chosa ni tsuite (sokuho) (Prompt report of the 5th Survey on information society and opinion of young people)*. http://www8.cao.go.jp/youth/kenkyu/jou hou5/g.pdf (Last access: Jan. 8. 2009)

Fukuda, Y. and Tani, K. 2003. Koko chiri kyoiku ni okeru GIS riyo no kanosei (Possibilities of using GIS in upper secondary school geography education). S*aitama chiri (Saitama Geography)*, 27, 17-25.

Itoh, S. 1999. Amerika gasshukoku no gakko kyoiku ni okeru GIS riyo no tenkai (Development of use of GIS in school education in the United States of America). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 8, 1-6.

Itoh, S., Ida, Y., and Nakamura, Y. 1998a. Gakko kyoiku ni okeru GIS riyo-amerika gasshukoku no doko to waga kuni no kanosei (Use of GIS in school education: trend in the United States of America and possibility in Japan). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 6-2, 65-70.

Itoh, S., Okabe, A. Okunuki, K., Shinoaki, S. Akita, Y. Kotsubo, H., Ookita, Y., Goto, H., Kaneko, T. Adachi, T. and Balsley, E. 1998b. Toshi keikaku kiso chosa ni okeru mobairu GIS riyou no kokoromi (sono1) (A trial to use the Mobile GIS for urban planning basic survey [pert1]). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 7, 137-140.

Itoh, S. and Ugawa, Y. 2001 Kankyo kyoiku ni okeru GIS riyo no kanosei (Possibilities of GIS in environmental studies). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 10, 249-254.

Johansson, T. ed. 2006. *Geographical Information Systems applications for schools – GISAS*. University of Helsinki.

Kanto Regional Agricultural Administration Office 2005. Heisei 17 nen kosaku menseki oyobi nosakumotsu sakutsuke (saibai) menseki (Gunma ken)(Area under cultivation and agricultural crops growing area in 2005). *Tokei Gunma (Statistics Gunma)*. http://www.gunma.info.maff. go.jp/jouho/H17/17koutimennseki.pdf (Last access: Jan. 8. 2009)

Kerski, J. J. 2003. The implementation and effectiveness of Geographic Information Systems technology and methods in secondary education. *Journal of Geography*, 102, 128-137.

Kobayashi, T. 2001. Excel wo riyo shita chiri joho no riyo ho (Usage of geographic information with Excel.) In *Jugyo no tame no chiri jouhou —shasin, chizu, intaanetto— (Geographic information for classes: images, maps and the Internet*, ed. Ida, Y., Itoh, S., Murayama, Y., Kokon shoin, 146-155.

Minamino, T. 2003. Waga kuni no gakko kyoiku ni okeru GIS katsuyo no genjo to kadai (Current conditions and issues of utilization of GIS in school education in Japan). *Chiri kagaku (Geographical Sciences)*, 58, 268-281.

Mizutani, C., Murayama, Y., Morimoto, T., Saitoh, T. and Kameyama, S. 2007. Fiirudo waaku wo shutai to shita kokosei muke GIS kyoiku- koko, daigaku, kenkyujo, GIS kigyo tono koraboreshon (Education for GIS for high school students based on the fieldwork: collaboration of high school, university, research institute and GIS vendor). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 16, 257-260.

Nihon Chishi Kenkyujo ed. 1968. *Nihon Chishi dai 6 kan Gunma ken, Saitama ken (Japan Chorography volume 6: Gunma prefecture and Saitama prefecture)*. Ninomiya shoten.

Ohzeki, Y. and Hayakawa, S. 2003. Chiiki sei wo tsuikyu suru GIS kyoiku no kanosei (Possibilities of GIS education seeking regional characteristics). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 12, 255-288.

Okunuki, K., Itoh, S., Okabe, A., Kaneko, T., Goto, H., Shinoaki, S., Tatematsu, T. and Shiozaki, T. 2000. Yagai chosa jisshu no tameno keitaigata GIS no kaihatsu- daigaku no chiri kyoiku ni okeru katsuyo jirei (Development of mobile GIS for field surveys: case study of utilization in geography education in university). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic*

Information Systems Association), 9, 263-268.

Sugimori, H. 2004. Yagai jisshu ni okeru keitai gata chiri joho shushu tuuru no tekiyo (Applying a mobile tool of collecting geographic information in outdoor survey.) In *Kyoiku GIS no riron to jissen (Theories and practices of education for GIS)*, ed. Murayama, Y., Kokon Shoin, 62-65.

Tani, K., Sato, T., Onishi, K., Okamoto, K. and Okunuki, K. 2002. Chugakko ni okeru chiri kyoiku. GIS no kaihatsu to kyoiku jissen (Development and practice of GIS for geography education in. lower secondary schools). *GIS : riron to oyo (Theory and Applications of GIS)*, 10, 69-78.

The Headquarters for the Promotion of an Advanced Information and Telecommunications Society 1999. *Kodo johoka shakai suishin ni muketa kihon hoshin- akushon puran (Basic policy for advanced information and telecommunication society-action plan-)*. http://www. kantei.go.jp/jp/it/actionplan/actionplan.html (Last access: Jan. 8. 2009)

Tatsuoka, Y. 2002. “Mijika na chiiki” gakushu ni okeru GIS riyo: jidohanbaiki chosa wo rei to shite (Applying GIS to "local area" study in social studies : a case of studing location of vending machines). *Naruto kyoiku daigaku gakko kyoiku jissen senta kiyo (Bulletin of Research Center for School Education, Naruto University of Education)*, 17, 85-94.

The Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society 2002. *e-Japan Strategy*. http://www.kantei.go.jp/foreign/it/network/0122full_e.html (Last access: Nov. 27. 2008)

Tinker, R. F. 1992. Mapware: Educational Applications of Geographic Information Systems, *Journal of Science Education and Technology*, 1, 35-48.

Uchida, H. 2007. GIS wo riyo shita chiri B ‘mijika na chiiki’ no shido-konbiniensu sutoa no ricchi bunseki oyobi kajuen chosa to sono happyo wo jirei to shite (Classes of ‘neighborhood area’ in Geograpahy B: case studies of location analysis of convenience stores and survey of fruit farms and presentation). *Gunma daigaku shakaika kyoiku ronshu (Bulletin of social studies education, Gunma University)*, 16, 38-45.

Ugawa, Y. and Itoh S. 2002. Kurikkaburu mappu to denshi keijiban wo mochiita kankyo gakushu chizu saaba no kaihatsu (Development of environmental study map server using clickable maps and electronic bulletin board). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 11, 225-230.

Yan, W., Sato, N. Sakaki, D., Koyama, T. 2001. Kankyo kyoiku no tame no WebGIS kankyo no kochiku (Building of the environment of WebGIS for environmental education). *Journal of the Center for Information Studies*, 2, http://www.yc.musashi-tech.ac.jp/~cisj/02/2-6.pdf (Last access: Jan. 8. 2009)

Yuda, M. and Itoh, S. 2007. Possibilities to utilize GIS in ESD – from research on GIS for secondary school teachers in Japan. *Geographiedidaktische Forschungen*, 42, 109-114.

Yuda, M., Itoh, S., Kizu, Y., Itou, J. and Moroda, T. 2007. Chugakko shakaika jugyou ni okeru keitai denwa GIS no riyou (Use of Cellular Phone GIS in social studies in junior high school). *Chiri joho shisutemu gakkai koen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 16, 251-256.

Chapter 5. Introducing GIS in school education: the Finnish case

5.1 Introduction

The application of GIS to school education has been pointed out in Japan (Itoh et al. 1998, Akimoto 1999, Ida 1999). Now, in the 21st century, with the rapid digitization of education, utilization of GIS in education is coming to be considered as a feasible aspect of geography education and many experimental practices have been conducted (Tatsuoka 2002, Tani et al. 2002 or Itoh et al. 2005). However, it has been said that GIS is rarely used in classes (Ida 2004). As seen in Chapter 2, the reality in school is that still very few teachers use GIS.

Such a slow pace of introduction of GIS into school education is not just found in Japan. Similar cases have been reported in other countries (Kerski 2001, 2003, Baker 2005). However, there is one country that fosters students' ability to read and understand maps from a geographical viewpoint as an essential requirement for using GIS from primary education and has already introduced a subject specifically for studying GIS in the national core curriculum. That country is Finland.

Finland has a very high academic level. The country has ranked number one in the world in the Programme for International Student Assessment (PISA) of the Organisation for Economic Cooperation and Development (OECD) since 2000 (Opetusministeriö, 2007). The content and method of education in Finland have, therefore, attracted attention in Japan (Fukuda 2006), but unfortunately, geography education in Finland has so far gone unnoticed in Japan. In Finland, geography is positioned as a bridge between natural and social sciences and is considered an important subject for fostering the ability to think logically. In the national core curriculum for upper secondary school announced in 2003, a subject featuring GIS was installed as “one of the greatest challenges for the future of geography education (Houtsonen 2003)” and this subject has been conducted all over the country since August 2005.

Some examples of practical use of GIS overseas have been introduced in Japan (Itoh et al. 1998, Itoh 1999). Most of the cases are in the United States and a few are in non-English-speaking countries such as Taiwan (Ida, 2004). Geography education in other countries has been introduced, such as education in the United States (Nakayama 1986, Minamino and Fujii 1992), England (Ueno 1994), New Zealand (Ida 1995), Sweden (Murayama 1996), Germany (Mizuoka 1981) and so on, but they do not mention GIS.

Consequently, focusing on education in Finland is worthwhile when considering the possibilities of widespread use of GIS in school education in Japan, because Finnish geography and GIS education have not been reported in Japan and the country has already introduced GIS into the national core curriculum which regulates the content of each subject.

In this chapter, the aim is to clarify the penetration of GIS in Finnish schools by questionnaire survey as well as the characteristics of geography education in Finland and the reasons underlying the ability to introduce GIS into school education by analysis of documents including the national core curriculum and textbooks, inquiry surveys and interviews in Finland with a view to promoting widespread utilization of GIS in school education in

Japan.

5.2 Survey on the use of GIS in Finnish upper secondary schools

5.2.1 Research outline and teachers' basic attributes

The questionnaire survey of teachers in Finland was a joint survey with the University of Helsinki. The survey was conducted from 2006 to 2007. The questionnaires were distributed by email to 380 geography teachers and biology teachers who also teach geography all over the country. The questions to the Finnish teachers were the same as the questions posed to the Japanese teachers in Chapter 2. Therefore, the content of the survey mainly covered their major subject, grades taught, degree of use of GIS and opinions on GIS (Appendix 5-1).

The response rate was 21.8% (83 teachers). 59% (49) of the respondents were female. Figure 5-1 shows the age of the respondents. There were few respondents in their 20s, because graduation from university means acquiring a Master's degree in Finland and students tend to study at university for a long time. Therefore, most teachers begin their careers as teachers later in life. The number of years of experience as a teacher showed the same tendency as the teachers' age structure (Figure 5-2).

69.9％ (58) of the respondents taught geography and 62.7％taught biology (52). 36.1％ (30) of the teachers taught both subjects, 2 teachers taught health education and 1 taught psychology besides geography or biology. Teachers who taught only geography were 33.7％ (28) and only biology were 26.5％ (22) (Table 5-1).

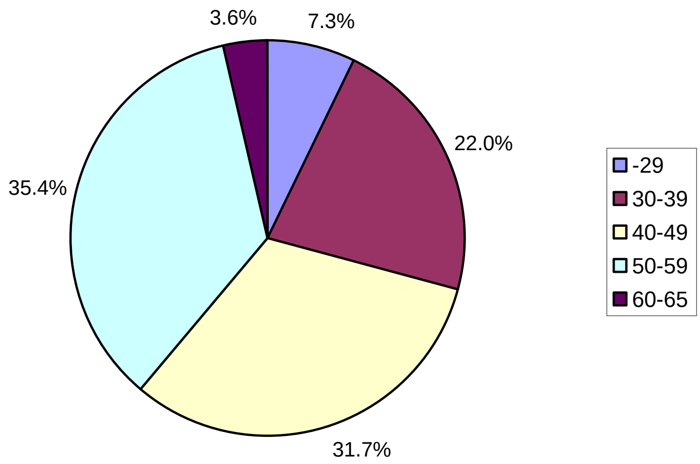


Figure 5-1 Age structure of the respondents

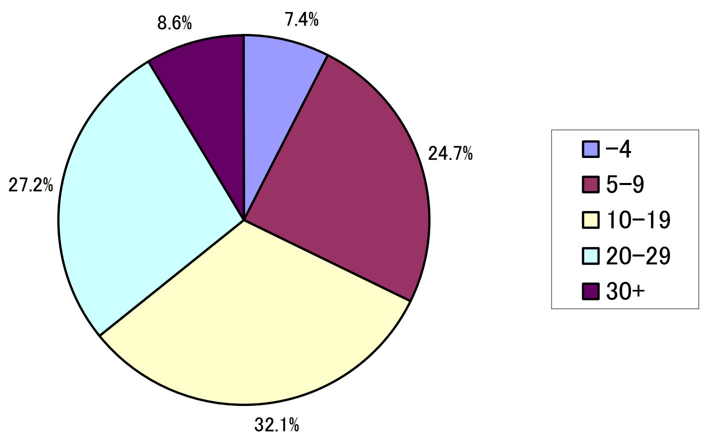


Figure 5-2 Work experience of teachers (years)

Table 5-1 Subjects taught

<table>
<tr><th colspan="3">Subject</th><th>(%)</th></tr>
<tr><td colspan="3">Biology</td><td>26.5</td></tr>
<tr><td rowspan="4">Geography</td><td colspan="2"></td><td>33.7</td></tr>
<tr><td rowspan="3">Biology</td><td></td><td>32.5</td></tr>
<tr><td>Health education</td><td>2.4</td></tr>
<tr><td>Psychology</td><td>1.2</td></tr>
<tr><td colspan="3">Unknown</td><td>3.6</td></tr>
</table>

(n=83)

Table 5-2 Familiarity with GIS

	(%)
Yes	90.4
No	9.6

(n=83)

Table 5-3 Previous experience in using GIS

	(%)
Yes	73.5
No	26.5

(n=83)

Table 5-4 Experience in using GIS in class

	(%)
Yes	62.7
No	37.3

(n=83)

Unlike in Japan, the Finnish respondents taught geography, biology or both subjects. Teachers can teach both subjects, because geography and biology belong in the same subject group and the 2 subjects have a strong relationship in Finland, and students who want to be geography teachers must major in geography and minor in biology at university, and vice versa.

5.2.2 Teachers’ knowledge of GIS and experience in its use

About 90% of the teachers (Table 5-2) answered that they were already familiar with GIS. Many of the respondents had participated in in-service teacher training workshops organized by the Finnish National Board of Education (Opetushallitus, hereinafter called FNBE), Finnish universities or the Union of Biology and Geography Teachers (Biologian ja Maantieteen Opettajien Liitto ry). Another way of learning about GIS among the respondents was studying on their own. Some of the teachers had learned about GIS at university during their Master’s Degree studies. So in both Finland and Japan, individual study of GIS and participation in in-service teacher training were the most important and top ranked methods of learning about GIS.

73.5％ of the teachers had some experience in using GIS (Table 5-3) and 62.7％ (52) had actually used GIS in classes. In contrast, in response to the same questions, 26％ of Japanese teachers had experience in using GIS and, as for practical use, 94.4％ of them had never used GIS in classes.

The software used by the Finnish teachers was GIS for professional use such as MapInfo and ArcGIS and free viewer applications provided by

MapInfo or ESRI bundled with textbooks. They used very expensive imported GIS software and paid-for data.

5.3 Introduction of GIS into Finnish education

The questionnaire survey above was conducted mainly in 2006, about 1 year after the new national core curriculum officially started. Although none of the teachers had used GIS in class, 90% of them answered that they already understood the concept of GIS and two-thirds had experience in use of GIS in classes.

The term 'GIS' first appeared in geography textbooks in Japan in 1995. Contrarily, in Finland GIS's first appearance was in the national core curriculum in 2003 and it took only 2 years to execute the national core curriculum in August 2005. How was it possible to introduce GIS into classes in such a short period?

To answer these questions, it is necessary to understand Finnish school education itself and the positions of geography and GIS in school education in that country. Here the author explains the school education system and geography education.

5.3.1 Education system in Finland

The Finnish education system is broadly divided into three phases (Figure 5-3). The first phase is basic education (Perusopetus) [1)]. Basic education starts at age 7. The 9 years of basic education comprise compulsory schooling. Schools that provide basic education are called basic

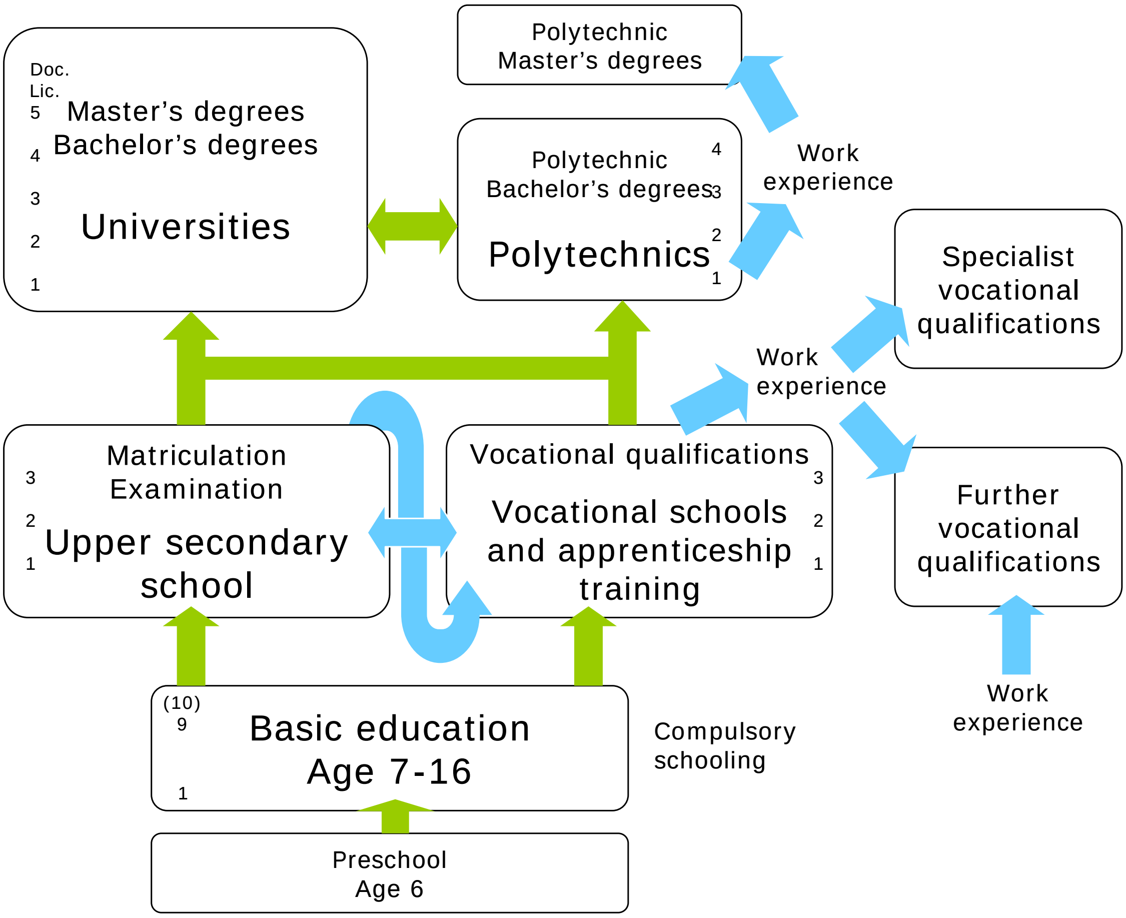


Figure 5-3 Finnish education system

(Source: Opetushallitus (2006))

schools (Peruskoulu). Most basic schools are separated into primary schools for grade 1-6 (Ala-aste) and lower secondary schools for grade 7-9 (or 10 [2)]) (Yläaste).

After basic education, upper secondary schools (Lukio) or vocational schools (Ammatillinen oppilaitos) provide upper secondary education. Higher education is provided by universities [3)] (Yliopisto or Korkeakoulu) and polytechnics (Ammattikorkeakoulu). After basic education, students have flexibility in their choice of school and all schools are open to all generations.

In Finland, most basic schools and upper secondary schools are run under the authority of the municipality [4)]. Although the detailed content of classes is decided by the educational committee organized by each school consisting of teachers and parents, the curriculum standards themselves have already been decided by the national core curricula (Opetussuunnitelman perusteet) issued by FNBE. Three national core curricula are issued for basic education and upper secondary school. Each curriculum explains the objectives of each subject and course content.

5.3.2 Position of geography in Finnish education

In Finland, the objectives of education and the lesson hours in school education are decreed by the Basic Education Act (Perusopetuslaki) [5)], General Upper Secondary School Act (Lukiolaki) [6)] and so on

In the Basic Education Act, geography is positioned in the group of environmental and natural studies which includes environmental study,

Table 5-5 Distribution of lesson hours in Finnish basic education

Subject	grade	weekly lessons*									
		1	2	3	4	5	6	7	8	9	Total
Finnish language and literature		14			14			14			42
Second/ foreign language	A-language	-------------			8				8		16
	B-language			---						6	6
Mathematics		6			12			14			32
Environmental studies		Environmental and natural studies									
Biology and geography			9			3			7		31
Physics and chemistry						2			7		
Health education									3		
Religion or ethics				6				5			11
History and social studies			----------------------------			3			7		10
Music					4–			3–			
Visual arts			Arts, crafts and physical education		4–			4–			56
Crafts			26		4–	30		7–			
Physical education					8–			10–			
Home economics		---						3			3
Educational and vocational guidance		---							2		2
Optional subjects									(13)		13
Pupil's minimum number of lessons		19	19	23	23	24	24	30	30	30	222
Voluntary A-language		------------				(6)			(6)		(12)

*　A weekly lesson means 38 lessons per year
–– :　The subject is not taught at this grade unless the curriculum states otherwise.
( )　is taught as an optional subject.

(Source: Opetushallitus (2004))

Table 5-6 Distribution of lesson hours in Finnish upper secondary schools

Subject/ subject group		Number of courses* Compulsory		Number of courses* Specialized
Finnish language and literature		6		3
Languages	A-language, starting in grade 1-6 of compulsory education	6		2
	B-language, starting in grade 7-9 of compulsory education	5		2
	Other language			16
Mathematics**	Basic syllabus	6		2
	Advanced syllabus	10		3
Environmental and natural sciences	Biology	2		3
	Geography	2		2
	Physics	1		7
	Chemistry	1		4
Religion or ethics		3		2
Philosophy		1		3
Psychology		1		4
History		4		2
Social studies		2		2
Arts and physical education	Physical education	5	2	3
	Music		1—2	3
	Visual arts		1—2	3
Health education		1		2
Vocational guidance		1		1
Compulsory courses		47—51		
Minimum total of specialized courses		10		
Applied courses***				
Minimum total number of courses		75		

* Lesson hours per subject is 38 hours on average.
** Take one syllabus, basic or advanced.
*** Elective specialized course subject

(Source: Opetushallitus (2003))

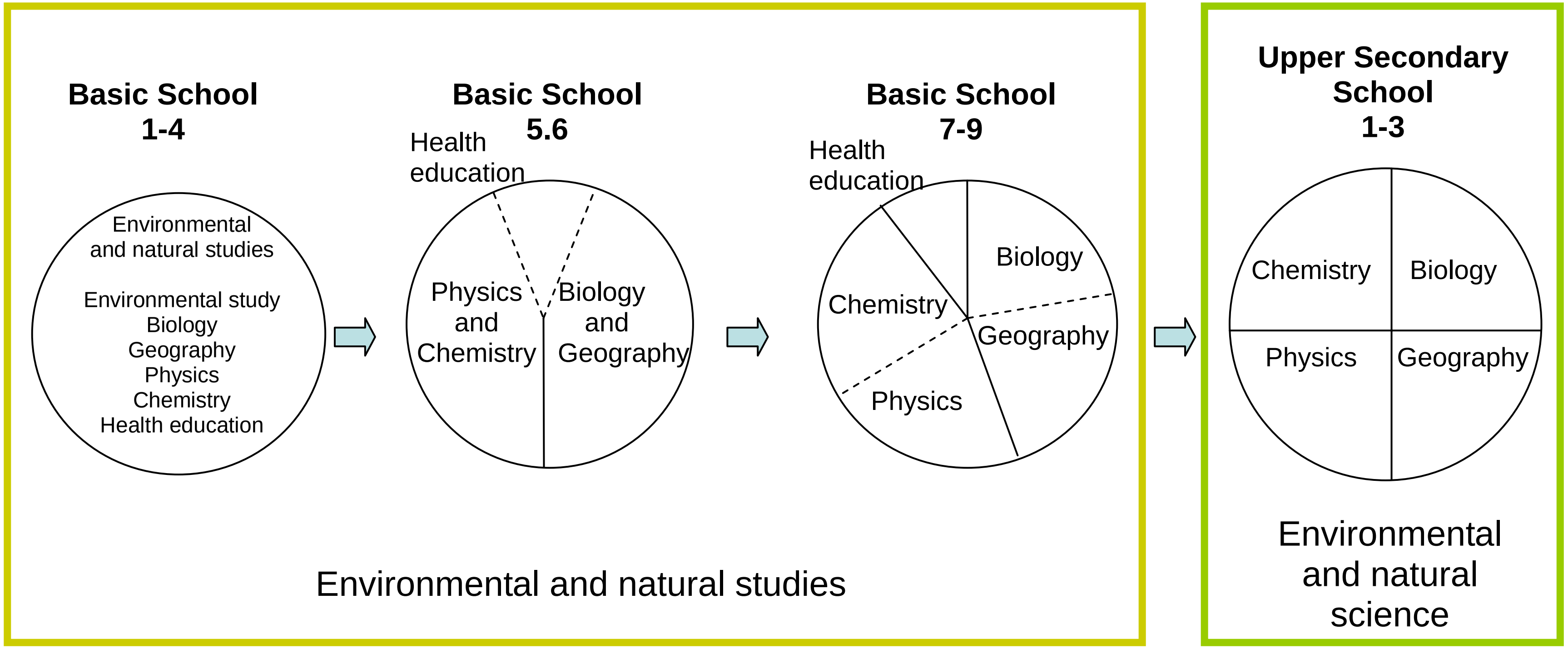


Figure 5-4 Position of geography in Finnish education

health education, physics, chemistry and biology (Table 5-5).

Also, in the General Upper Secondary School Act, mathematics and environmental and natural sciences are divided into mathematics and environmental and natural sciences, and biology, geography, physics and chemistry are in the latter group (Table 5-6).

In Japan, geography is a social studies subject. In Finland, although educational content in physical and human geography is included, geography belongs to the same environmental and natural science group as physics, chemistry and biology.

Pupils study geography in ‘Environment and natural studies’ with health education, physics, chemistry and biology from 1st to 4th grade and in ‘Biology and geography’ in 5th and 6th grade, and then in ‘Geography’ as an independent subject in basic school (Figure 5-4). As shown in Table 5-5, the distribution of lesson hours is geography with biology in basic education.

The relationship between geography and biology is not only seen in basic and upper secondary school education but also in university. As mentioned above, as university students who want to be geography teachers must also study biology, the relationship between the 2 subjects is widely recognized throughout education in this country.

The advantage of geography being in the subject group of environmental and natural sciences is that students can use their geographical skills and geographical way of thinking or perspective when they study other scientific phenomena. Actually, maps are used in physics and chemistry textbooks.

In Finnish education, geography belongs to the natural sciences and has a strong connection with biology. This position of geography is a notable characteristic of education in this country.

5.3.3 Geography education in the new curricula

The new national core curriculum for upper secondary schools was issued in 2003 and in 2004 for basic education. The new curricula came into effect in basic education from 2004 to 2006 [7)] and in upper secondary schools from August 2005.

The following explains the content of geography classes in basic schools and upper secondary schools as written in the national core curricula.

1) Basic school, grade 1-4: 'Environmental and natural studies'

From grade 1-4, there is a subject called 'Environmental and natural studies (Ympäristö- ja luonnontieto).' 'Environmental' in the name of the subject includes many meanings such as habitat, living environment, natural environment [8)] and social environment. Also, 'natural' is understood to mean the same as environmental (Lahti 2000). Therefore, this subject is an integrated subject group comprising the fields of biology, geography, physics, chemistry and health education. With instruction in the subject relying on an investigative, problem-oriented approach (Opetushallitus 2004), the pupils get to know and understand nature and the built environment, themselves and others, and so on.

There are 2 main objectives in the geographical field. One is learning to read and draft simple maps and to use an atlas. The other is getting the students to perceive their home region as a part of Finland and the Nordic countries (Table 5-7).

In the 1st grade, pupils develop spatial cognition and view different kinds of solid figures from many aspects. In their textbook, a bird's-eye view of a town appears, so pupils know what a town looks like from above.

In 2nd grade, there is a unit dealing with maps. Pupils learn the definition of a map and compare a bird's-eye view of a town with a map of the same area (Figure 5-5). At this time, the map is explained as a "small representation of an area which has been reduced in size, as seen from above (Nuutinen et al. 2005b)." Also, they study different scale maps ranging from their own room to the earth.

In 3rd grade, the definition of a map is expanded to "on the map there are explanations using colors and symbols (Honkanen et al. 2006)" besides the definition explained in 2nd grade. In the textbook, an aerial photograph and map on a scale of 1 to 20,000 [9)] are introduced and students learn how to make maps, read maps and use the compass. It follows that pupils come to be able to identify what is drawn on the map with the neighborhood where they live. Also, through working with maps, they come to realize the characteristics of Finland with its many lakes and unique landscape and learn how the land in their country is shaped.

In 4th grade, pupils learn about latitude and longitude, migration, the landscape in Nordic countries, vegetation, agriculture, fisheries, energy and diversity of languages through maps. Also, they study the basic data of countries (Honkanen et al. 2005).

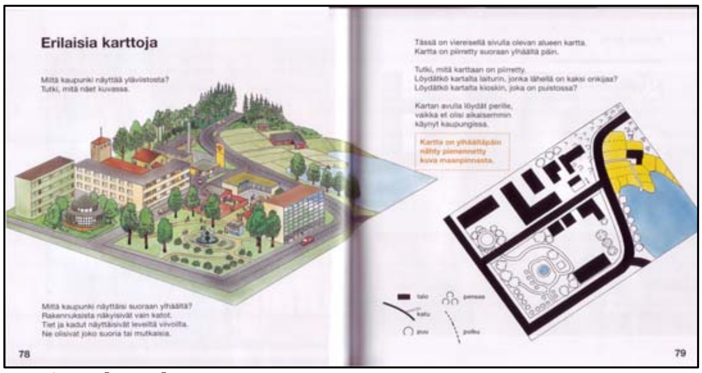
In the 'environmental and natural studies' textbooks at each grade, many

Table 5-7 Objectives in geography and related courses in the Finnish national core curriculum

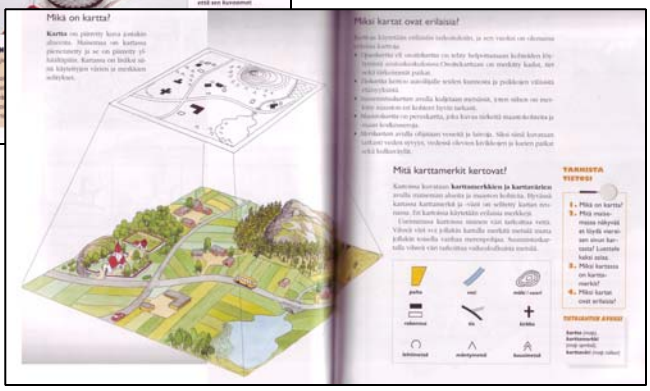
Basic education			Upper secondary school
Environmental and natural studies (Grades 1-4)	Biology and geography (Grades 5-6)	Geography (Grades 7-9)	Geography
• learn to act safely, so as to protect themselves in their environment, and to follow instructions at school, in the immediate environment, and in traffic • get to know the natural and built environments in their neighborhood, to observe the changes happening therein, and to perceive their home region as a part of Finland and the Nordic countries • learn to obtain information about nature and the environment by observing, investigating, and using a variety of source materials • learn to make observations using the different senses and simple research tools, and to describe, compare, and classify their observations • learn to perform simple scientific experiments • learn to read and draft simple maps, and to use an atlas • learn to represent information about the environment and its phenomena by different means • learn to use the concepts by which the environment and the phenomena and subjects embraced by those concepts are described and explained • learn to protect nature and to save natural resources • learn to develop their psychological and physical self-knowledge, respect for themselves as individuals, respect for others, and social skills • learn concepts, vocabulary, and procedures relevant to health, disease, and the promotion of health, and learn to make choices that promote health	• get to know about species, their structure and life, and their adaptation to their living environments • learn to perceive a population as a whole and to classify organisms • learn to move about in the natural environment and observe and investigate nature outdoors • come to understand that people depend on the rest of nature in their food production • develop their environmental literacy, act in an environmentally friendly way, care for their local environment, and protect nature • know the basic facts about the human anatomy and vital functions • respect growth and development as each individual’s personal process, recognize the identifying characteristics of puberty, and understand human sexuality • ponder questions bearing on growth, development, human diversity, and social interaction • take responsibility for their own actions and take other people into consideration • draw and interpret maps, and use statistics, diagrams, pictures, and electronic messages as sources of geographic information • perceive a map of the world and know its main nomenclature • understand the dependence of human activity on the possibilities that the environment offers on earth • familiarize themselves with Europe’s geography and the world’s other regions and learn to appreciate and take a positive attitude towards other countries and their peoples and cultures	• learn to use and interpret physical and thematic maps and to use other sources of geographic information, such as diagrams, statistics, literature, news sources, electronic messages, and photographs, including aerial and satellite photographs • learn to determine the location of regions and the distances between places • come to understand the effects of planetary events on the earth • come to understand the effect on the landscape of factors that reshape the earth’s surface • come to understand the interaction between natural and human activity in Finland, elsewhere in Europe, and elsewhere in the world; they will come to know the reasons that guide the location of human functions • learn to recognize the features of different cultures and to take a positive stance towards foreign countries, their peoples, and representatives of various cultures • come to know and value Finland’s natural and built environments; they will learn to perceive their own regional identity • know how every citizen in Finland can have an impact on the planning and development of his or her living environment • understand and evaluate critically news information on such issues as global environmental and development questions, and learn to act in accordance with sustainable development themselves	• be able to acquire, interpret and critically assess geographical information, such as maps, statistics and printed, digital and other media sources, and know how to make diverse use of information technology to present geographical information • understand the meanings of spatiality, space and place in geography and geographic thinking • be able to describe regional phenomena, structure and interdependencies of nature and human activity and to assess current word events critically • be able to observe, analyse and assess the state of nature and built environments, changes occurring in these and human well-being both locally and globally • understand the meaning of regional development and be able to consider different opportunities to resolve problems of economic and social inequality • be familiar with and understand different cultures and tolerate and appreciate diversity • be able to function as citizens of the world taking a justified stance on issues concerning the surrounding world and acting positively towards sustainable development

(Source: Opetushallitus 2003, 2004)

1) 1st grade



2) 2nd grade



3) 3rd grade

Figure 5-5 Textbooks for "environmental and natural studies" in Finnish basic schools
(Nuutinen et al. 2005a, 2005b and Honkanen et al. 2006)

maps are used. In the unit on geography with biology, physics and chemistry, fieldwork using maps is introduced.

Pupils who have studied different scales and kinds of maps can understand the position of the place where they live and the relationship between that place and other places, even as the study area is expanded from neighborhood to province, country, the Nordic countries and Europe.

As for map skills, units in this subject are designed as follows. As the first step, pupils study the definition of a map and how to make a map. The second step is understanding the functions and characteristics of the map. And then they master how to use and interpret maps. This is because map literacy is considered an important skill that fosters the ability to solve problems from multiple points of view. Therefore, the educational content stresses acquiring such skills and this idea is reflected in the content of classes and textbooks.

2) Basic school, grade 5-6: ‘Biology and geography’

In grades 5 and 6, ‘environmental and natural studies’ is divided into ‘Biology and geography’ and ‘Physics and chemistry.’ Geography education in ‘Biology and geography’ deals with various regions in the world to develop pupils’ conception of the world from Finland to the whole of Europe and the rest of the world.

The objectives of the subject include map study. In addition to drawing and interpreting maps, pupils use statistics, diagrams, pictures and electronic messages as sources of geographic information, perceive a map of the world and know its main nomenclature.

The core content of the geography field is map skills, together with maps, climate, vegetation and human activities of Europe, the diversity of human life and the interaction of nature and human activities in the world.

Here map skills means that pupils know how to use an atlas, make use of the map symbols and scale when reading a map, know how to interpret various maps, statistics, diagrams and pictures, and in addition, know how to draw simple maps and diagrams by themselves (Opetushallitus 2004).

In Finland, pupils have already learned about Finland and the Nordic countries by the fourth grade, so they study the geography of Europe and other regions of the world. In the textbooks, there are many thematic maps on climate vegetation distribution, agriculture and industry in Europe, Africa, the Middle East and the rest of the world. Through these maps, they learn the characteristics of each area and consider the factors that produced them.

3) Basic school, grade 7-9: ‘Geography’

From the 7th grade, that is, lower secondary school, geography becomes an independent subject. In Finland, geography is a compulsory subject which all students must study during the basic school years (Butt et al. 2006).

The national core curriculum says that instruction in geography in these grades “must serve as a bridge between natural-science and social-science thinking” (Opetushallitus 2004). During these three years, students acquire the ability to examine the natural, built and social environments, and interaction between people and the environment at local to global level. Then, they consider the cause-and–effect relationship of the natural-science, cultural, social and economic phenomena that occur in the world from many aspects.

The objectives are to learn to use and interpret physical and thematic maps and to use other sources of geographic information, such as diagrams, statistics, news sources, and aerial and satellite photographs. Moreover, students come to understand the earth as a planet, understand geomorphological processes and interaction between nature and human activities in Finland, Europe and the world, and come to recognize diversity in the world and so on. The study content on map literacy shifts to enhancement and utilization of the skills which students have already acquired.

The term ‘GIS’ does not appear in the national core curriculum for basic education, but some of the objectives mentioned appear to be related to GIS, such as use of statistics and visualization of geographic information with the aid of maps and drawings. Furthermore, learning the basic concepts of GIS is included in classes.

In the textbooks for the 3 years from grade 7 to 9, units on GIS (Paikka-tietojärjestelmät) [10)] appear, and students acquire the knowledge, skills and perspective to use GIS (Table 5-8). They learn the concepts and structure of GIS, database and coordinates, and review their map skills so far (Figure 5-6).

The author interviewed a geography teacher at the Viikki Teacher Training School, University of Helsinki (Helsingin yliopiston Viikin normaalikoulu). In class, the teacher gave the students an assignment to research a country that they were interested in. Each student collected data

Table 5-8 Content of maps and GIS in geography in Finnish lower secondary school

Global environment (7th grade)	Travel to Europe (8th grade)	Destination: Finland (9th grade)
− Basic cartography − Map projection − Scale − Map symbols and colors − Geographic information and GIS	− Satellite and aerial photo images − Thematic maps − Concept of GIS − Geographic (positioning) information and map − Survey with the Internet	− Reading a topographic map − Scale, directions, map symbols, coordinates − Various maps − Neighborhood survey

(Source: Cantell et al. 2005, 2006 and Cantell et al. 2006)

Paikkatiedot – maantiedettä ja tietotekniikkaa

Tähdellisiä kysymyksiä

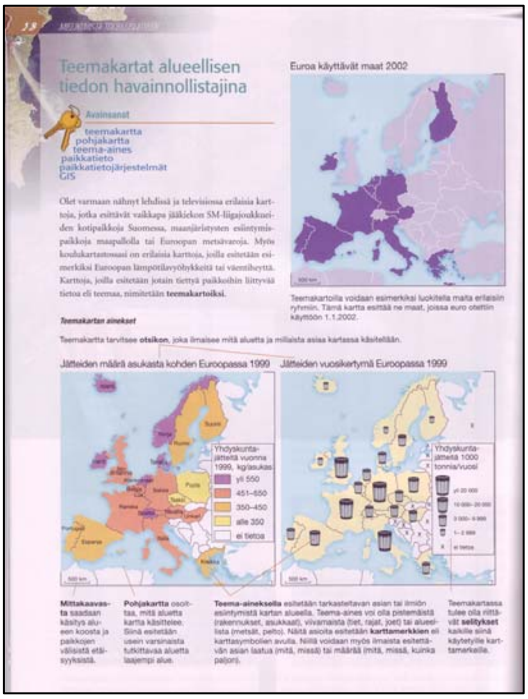
1. Miksi maapalloa on vaikeaa kuvata litteänä karttana?
2. Miten eri puolilta maapalloa kotoisin olevat kartat voivat erota toisistaan?
3. Mikä on kartan mittakaava?
4. Mitä tarkoitetaan suurimittakaavaisella kartalla ja mitä pienimittakaavaisella?
5. Miten korkeuseroja kuvataan kartalla?
6. Minkä suuntaisesti leveyspiirit kulkevat maapallolla?
7. Mistä mihin pituuspiirit kulkevat maapallolla?
8. Mitä tarkoittaa käsite GIS?

Paikkatiedot: maantieteen ja tietotekniikan liitto

Paikkatietojärjestelmän osat

Tähdellisiä kysymyksiä

1. Mikä on teemakartta?
2. Millaisia osia on hyvässä teemakartassa?
3. Millaisista tiedoista paikkatieto muodostuu?
4. Millaisista asioista paikkatietojärjestelmät koostuvat?



Teemakartat alueellisen tiedon havainnollistajina

Euroa käyttävät maat 2002

Jätteiden määrä asukasta kohden Euroopassa 1999

Jätteiden vuosikertymä Euroopassa 1999

Figure 5-6 Textbooks on GIS in lower secondary school in Finland

(Cantell et al. 2005, 2006 and Cantell et al. 2006) on the country, manually created many kinds of thematic maps using the data and produced a report. The purpose of the task was for the students to acquire the concept of ‘positioning information (paikkatieto)’ whereby every place (paikka) has attribute data (tieto). The teacher said the experience of collecting data and drawing maps by hand helped students to understand the idea of GIS visualization of data on a map. However, GIS software was not used in this assignment or in class. The reason for this was that, if GIS were introduced, students would concentrate on operating the software and might miss the core idea of GIS.

Actually, there is no mention of operation of GIS software in the national core curriculum. Teachers understand that it is important for students to acquire the concept of ‘positioning information’ at lower secondary school level.

Such geographical skills and perspective as above taught in these grades seem to be a prelude to geography in upper secondary school, including the introduction of GIS.

4) Upper secondary school: ‘Geography’

a) Geography as science: courses and objectives

In basic education, geography (maantieto) is “knowledge (tieto) of the earth, country and land (maa)”. But in upper secondary school, knowledge changes to science (tiede) and the name becomes geography (maantiede). Geography education in upper secondary school helps students to understand global, regional and local phenomena and problems and potential solutions to such problems (Opetushallitus 2003).

The objective of this subject is to learn to use geographical knowledge to perceive factors that influence the changing world and form justified opinions, take a stance on changes in local areas and in the world as a whole and actively contribute to the promotion of the well-being of nature and human beings. As shown in Table 5-7, the concrete objectives regarding skills relevant to using GIS are to acquire, interpret and critically assess geographical information, such as maps, statistics and printed, digital and other media sources, and know how to make diverse use of information technology to present geographical information and to understand the meanings of spatiality, space and place in geography and geographic thinking (Opetushallitus 2003).

There are 4 courses in geography in upper secondary school. Two courses are compulsory: "The blue planet (Sininen Planeetta) (GE1)" and "A common world (Yhteinen maailma) (GE2)." The former is physical geography and the latter is cultural (human) geography [11)]. The other 2 courses are specialized elective courses (Syventävä kurssi). One is "A world of hazards (Risken maailma) (GE3)" and the other is "Regional studies (Aluetutkimus) (GE4)." In the course on physical geography named "The blue planet," students learn about the planetary nature of the earth, atmosphere, hydrosphere, weather and climate, topography and vegetation. Although this core content seems to be similar to earth science, the subject is geography [12)] and it starts with understanding geography as a natural science, geographical knowledge content, research methods and the research process. Students master the interpretation of natural landscapes using maps and images in this subject.

Table 5-9 Objectives of geography course in Finnish upper secondary school

Compulsory courses		Specialization courses	
GE1：The blue planet	GE2：A common world	GE3：A world of hazards	GE4 : Regional studies
Physical geography	Cultural (Human) geography	Hazard geography	GIS
• be able to use the basic concepts of physical geography • understand the phenomena arising from the planetary nature of the globe • be able to describe the structures and functions of the atmosphere, hydrosphere and lithosphere • understand how and why natural landscapes change and know how to interpret the structures, origins and development of natural landscapes using images and maps • understand the zonality of living and lifeless nature on the globe • know how to apply the physiogeographical information that they have acquired both locally and globally	• know how to use the concepts of cultural geography and to interpret phenomena and structures related to human activity, making use of the theories and models of cultural geography • be familiar with different cultures and be able to assess factors that have contributed to their development • be able to analyse population trends and settlement characteristics in different regions of the world and the causes and effects of urbanisation • be able to assess the effects of opportunities provided by natural resources and the environment on human activity in different regions and understand the significance of ecologically and economically sustainable development • be familiar with the objectives of regional planning and its means to influence • be familiar with the different manifestations of differences in development; • be able to assess people’s well-being, the state of the environment and culturally and socially sustainable development today and in the future in the different regions of the world	• be familiar with hazards related to natural phenomena, human activity and interaction between human beings and nature on the globe and be able to assess the significance of these to the people and the environment • be familiar with the types of hazards occurring in different areas of the globe and be able to compare and assess the susceptibility of different areas to global and local hazards • be able to assess the relationship between the development stages of and hazards occurring in different areas • be able to follow and critically assess current news of hazards in different media and know how to apply the knowledge they have learnt to analysis and assessment of such news • be aware of the types of solutions that may be employed to avoid threats or mitigate their effects • understand that human activity affects the viability of the globe and the safety and well-being of people • be aware of opportunities to anticipate and prepare for hazards, control conflicts and act in accordance with sustainable development	• command the basics of cartography • be familiar with the principles and applications of GIS • be able to collect information related to a certain area using various means, such as field observations, questionnaire surveys or interviews and atlases, maps, statistics and other sources • know how to use information network for the acquisition and interactive editing of material and in the publication results • know how to visualise geographical information in the form of maps, diagrams and photographs • be able to analyse and interpret the material that they have acquired and, based on this, prepare a description of the area in question • command the principles of scientific writing, such as critical use of sources and referencing techniques, and be familiar with copyrights

(Source: Opetushallitus 2003)

In the other compulsory course, “A common world”, students learn to understand population, settlements, natural resources, industries, regional structure and so on through a cultural (human) geographical approach and consider sustainable development. Students learn the approaches and perspectives of cultural (human) geography, geographical perception and perception of places. Of course, interpretation of cultural landscapes using maps and pictures is included in the core content.

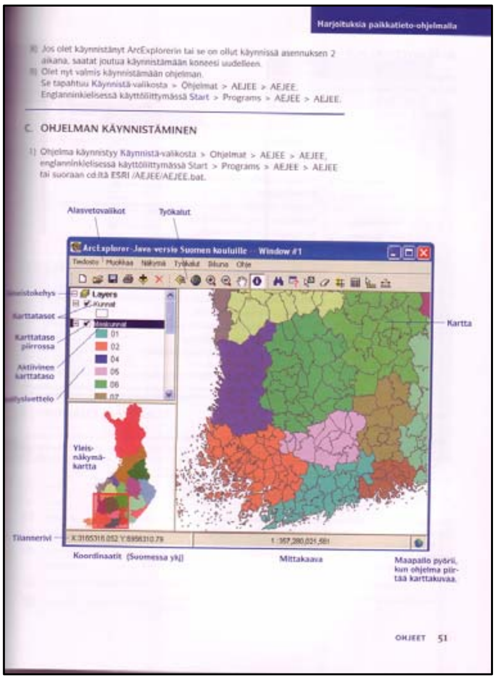
As seen above, all compulsory geography lessons introduce a study unit to acquire skills to interpret maps and geographic information (Table 5-9).

“A world of hazard” is a specialized course in hazard geography. In the course, students learn the classification and significance of hazards and consider preparation or prevention of many different hazards. Types of hazards here include natural, human, environmental related to human beings and nature and technological. The course focuses on the role of this subject as a bridge between nature and social sciences. The course outside the framework of geography is that students can practice applying their acquired skills and knowledge to analyze and understand various phenomena in the world.

b) Specialized GIS course: “Regional studies”

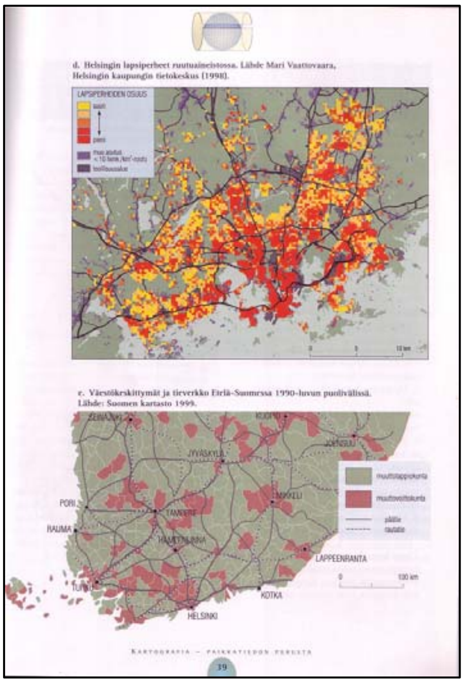
The other specialized course, “Regional studies,” enables students to learn about GIS and conduct field research using their knowledge and skills.

This subject is broadly divided into 3 phases. The first step is to study the basics of cartography, methods of regional survey and acquisition and utilization of geographic information. Students acquire the basic knowledge

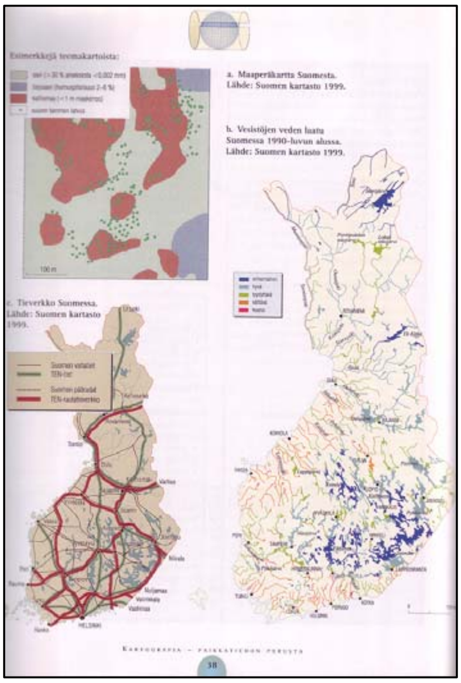


1) Explanation of the interface of GIS application (ESRI's Arc Explorer)

2) Explanation of the concept of a database



3) Examples of maps made by GIS application



4) Another example of maps made by GIS application

Figure 5-7 Images from a regional studies textbook (GE4) for upper secondary school in Finland (Löytönen et al. 2003 and Fabritius et al. 2006)

Table 5-10 Content of textbooks on “GE4: Regional Studies”

“Globus GIS”	“Lukion Maantiede 4: Aluetutkimus” (Upper secondary school geography 4: Regional studies)
Geographic Information System in a nutshell	*Cartography*
- What is GIS?	- History of cartography
Cartography — Basics of Positioning Information	- Remote sensing
- What are maps and cartography?	- Map-drawing
- Basics of map	- Various maps
- Types of maps	- Definition of position with maps
- How to draw maps and depiction	*Geographic Information System*
Geographic Information System	- Positioning information and GPS
- Where was GIS born?	- Structure and data of GIS
- Positioning information	- How to use GIS
- How to collect positioning information	- Raster and vector data
- Survey and analysis	- Survey, analysis and visualization
- Presentation of positioning information	*Practice using GIS application*
GIS in practice	- How to use Arc Explorer
- Use of GIS in Finland	- Practice 1 Get to know Arc Explorer
GIS, study and evaluation	- Practice 2 Data on municipalities
- Research study and GIS	- Practice 3 Nature in Jyväskylä Seutukunta**
- GIS course and evaluation	- Practice 4 City of Jyväskylä
Practices (Mapinfo)	*Own regional study*
- Map management	- Instruction in research
- Analysis of attribute data	- Instruction for research at municipality level
- Interaction between humans and nature in Nastola*	- Instruction for research at state level
- Map servers on the Internet	

* Name of a municipality in southern Finland

** Sub-region in province (maakunta) in Finland. Seutukunta consists of a number of municipalities.

(After Löytönen et al. 2003 and Fabritius et al. 2006) for using GIS and conducting surveys. Secondary students learn about GIS itself and its utilization. They learn the basics of GIS and its applications as well as processing, interpreting and visualizing geographic data using GIS software (Figure 5-7). Then, they actually conduct a survey using GIS and write a report on a study area. The topics under research are natural conditions, population and settlement patterns, land use, economy, transportation, services and so on. In the course of the survey, after selection of the research area, students collect and process materials such as maps, statistics, digital GIS material and other sources of information, and then they interpret them and write a brief report (Table 5-10).

In this course, students operate GIS software themselves. According to the textbooks, cartography and concepts of GIS as well as practice in using GIS applications are introduced.

In Finnish education, projects are often implemented by groups. This is significant for developing decision-making skills and communication skills through group work. In classes in "regional studies" both individual work and group work are recommended.

The author interviewed a teacher teaching geography in the natural science high school of Helsinki (Helsingin Luonnontiedelukio). In this upper secondary school, students could choose an area, conduct research and prepare reports as individuals or in groups.

In the "regional studies" class, students made a large map consisting of different thematic maps of the study area drawn on plastic transparent sheets (Figure 5-8). This is just like combining layers in GIS. Using these maps,

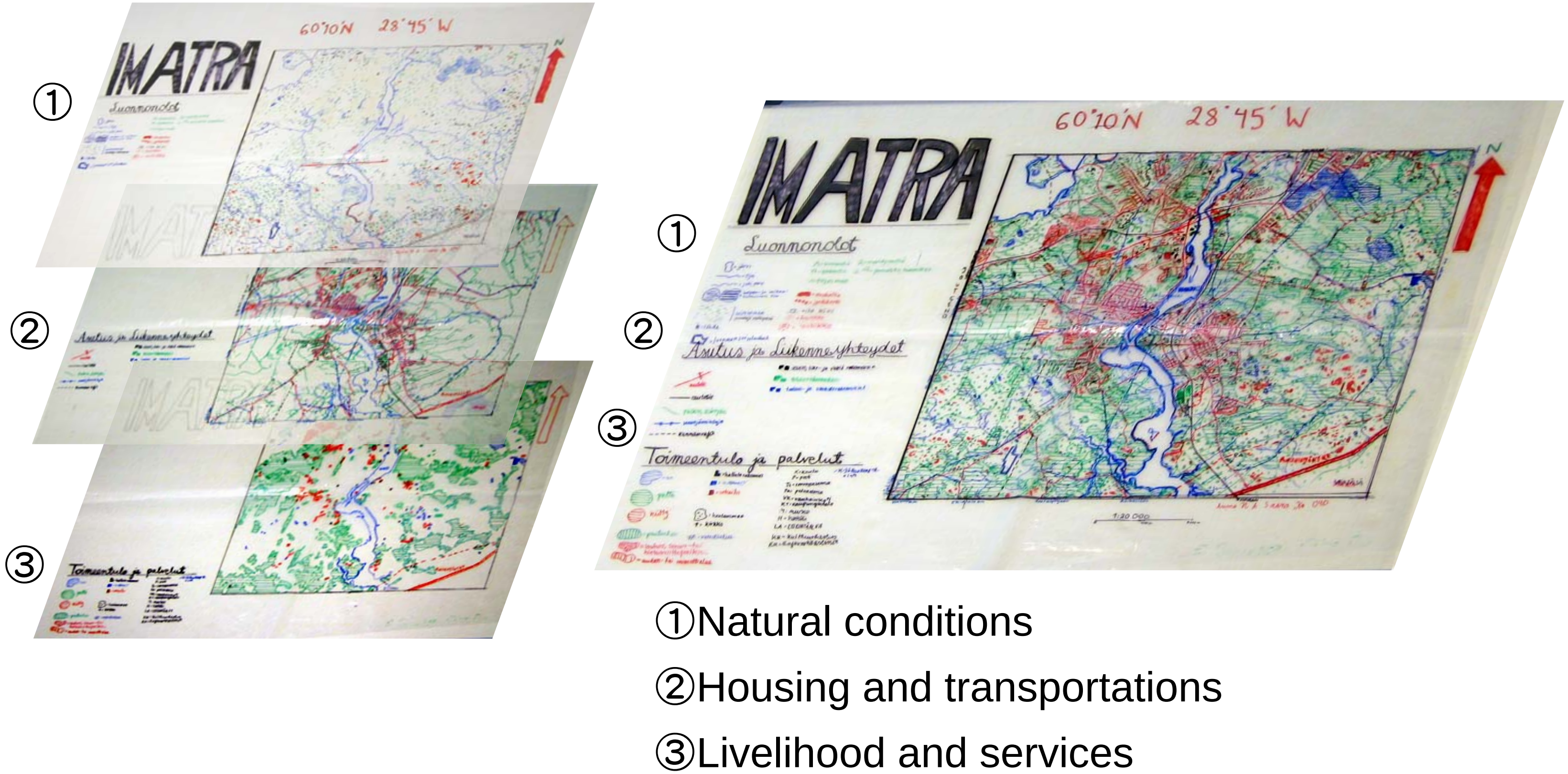


Figure 5-8 Thematic maps on Imatra, Finland, made with transparent sheets by Finnish upper secondary school students

(Author's survey in August 2006)

they considered the characteristics of the study area and wrote a report based on their research results.

On this course, students learn how to operate GIS, so they discover things from the vast information available using this tool and understand their findings.

5. 4 Ways of introducing GIS in Finnish school education

How did Finnish education make the introduction of GIS possible at the national core curriculum level? It is possible to consider the question from 4 key aspects: educational content, formulation of the basis for implementation of the new national core curricula such as research for curriculum design and training of teachers in the use of GIS, the school environment and cooperation with other countries (Figure 5-9). Each factor is explained below.

5.4.1 The national core curriculum containing GIS

1) GIS education through map education

Geography education in Finland is characterized by fostering students' spatial thinking and guiding students to acquire map reading skills throughout basic education and upper secondary education. In basic schools, pupils learn how to read maps and understand the basic concept of GIS that "every place has its own data," and they undertake a course in GIS including operation of the software at upper secondary school level.

In basic education in Finland, pupils read many maps and make maps by

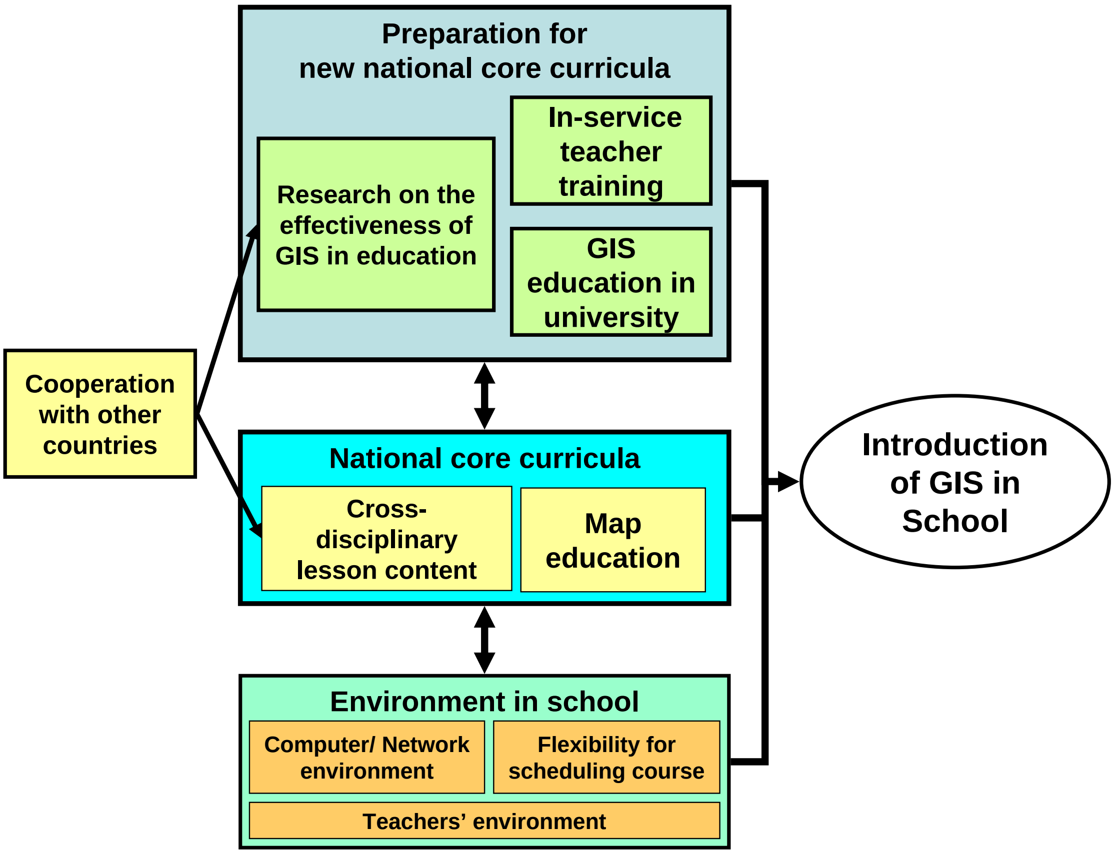


Figure 5-9 Diagram showing introduction of GIS in school education in Finland

hand. Ratinen and Johansson (2005) pointed out the possibility that such experience of making freehand maps may motivate students to make maps with GIS.

As already seen, students receive map education from the 1st grade in basic school, and then GIS software is introduced at upper secondary school level after students have grasped the concept of GIS. Such comprehensive curricula throughout basic and upper secondary education in this country are commendable.

2) Cross-disciplinary lesson content

An additional background to GIS introduction is that interdisciplinary themes are dealt with in Finnish education. As already mentioned, geography is one of the natural science subjects, and some geography content is integrated into other natural science subjects. For example, in the unit dealing with environmental issues, students conduct a water quality survey by scientific approach, and in addition, they visualize the data using maps and analyze the problems from the perspective of population or economic activity as social factors. Thus, thinking abilities, such as grasping data spatially and analyzing and considering phenomena, are developed not only by geography but together with other subjects.

In Finland, it can be said that map education in primary and secondary education and a learning environment which develops a geographical view and perspective in other subjects built the foundation for introducing GIS.

5.4.2 Formulation of the basis for installing the new curricula

1) Experience and research of experts in designing the curricula

The research achievements of experts in the geography division of FNBE contributed to the introduction of GIS in the national core curriculum. According to an interview with Dr Houtsonen, a counselor in geography education, FNBE, in 2006, in addition to global trends in geography education such as informatization and practice in pedagogical methods dealing with immediate problems, their research findings on practical use of GIS in primary and secondary education in the United States [13)] influenced the introduction of this tool. The FNBE carried out an upskilling project for math and natural science teachers (LUMA-ohjelma) from 1996 to 2002. GIS was included as a topic in the project. In 2001, the University of Helsinki established a pilot project called 'GIS in teacher education' to evaluate the effectiveness of classes using GIS in upper secondary schools and provide training to teachers (Johansson 2003). The project included a survey of water pollution in lakes using GPS and analysis of collected data using GIS. Through this experiment, findings were observed in support of the effectiveness of utilizing GIS in classes, such as students realizing the fun of geography and studying with a more positive attitude. Therefore, the FNBE decided to introduce GIS.

2) Training for in-service teachers and university education

In Finland, GIS has been introduced in geography in upper secondary school. In basic education, some content on GIS appears in the national core curriculum. Therefore, the Ministry of Education has organized GIS courses for in-service teacher training conducted by local universities in training centers [14] around Finland since 2000. For example, the University of Helsinki has a course with a 5-day workshop including exercises in GIS and e-learning at home. These workshops are conducted not only by the departments of geography but also by the biology departments in the universities. Also, other organizations such as Finnish universities, the Union of Biology and Geography Teachers and the Finland Forest Association (Suomen metsäyhdistys ry) hold GIS workshops.

Furthermore, the Ministry of Education has provided financial support for GIS education for students on teacher training courses in universities since 2001. The aim of this support is to ensure that the students receive quality GIS education. Before 2005, most GIS-related lessons were elective, but nowadays it is obligatory for all students on teacher training courses in all universities to study GIS.

5.4.3 School environment in which GIS is introduced

1) Improvement of software and hardware environment

One of the biggest problems to using GIS in schools is the computer environment such as the availability of computers and software. As in Japan, nearly all schools have computer rooms, and some schools have already installed expensive GIS software. But these schools are in municipalities which understand the value of GIS. As mentioned above, the management of each school falls under each municipality, so the equipment in the schools depends on the policies of the municipality. Also, digital map data issued by the National Land Survey of Finland (Maanmittauslaitos) is not free of charge. Purchase of such data depends on the budget of the municipality. So the environment surrounding the software or data is different in each school. But the new textbooks on regional studies bundle Arc Explorer or a MapInfo viewer and data in the textbook. As far as using the new textbooks is concerned, every school can make classes with GIS [15)].

2) Flexibility in scheduling courses and teaching environment

One problem in using GIS in classes is that teaching the GIS application and doing field surveys are time-consuming. How do Finnish schools overcome this problem?

The "Regional studies" course consists of 38 hours a year on average. This is more or less equivalent to once a week for a year. But according to the questionnaire to upper secondary school geography teachers in Helsinki, the lesson hours in regional studies differ from school to school. Schools have 90 hours a year maximum and 30 hours minimum, 5.4 hours a week on average, and classes are conducted intensively for from 6 to 18 weeks. This is because the Finnish academic year is divided into fall and spring semesters and each semester consists of 2 quarters. Therefore, the course can be conducted intensively in one quarter or one semester.

Such flexibility in the school environment whereby courses can be conducted in a short time makes classes with fieldwork and acquisition of software operation possible.

Also, teachers can concentrate on teaching their specialized subjects. Unlike Japan, they do not need to take charge of classes. So they have time to brush up their knowledge and skills in their spare time, and this is to be recommended.

5.4.4 Cooperation with other countries

Finland conducts projects in education with GIS in cooperation with other European countries. For example, GISAS (Geographical Information Systems Applications for Schools) is an educational research project funded by the Minerva Action of European Commission [16)] and coordinated by the University of Helsinki for 3 years from 2003. In this project, educational institutions in Slovenia, Belgium, France, Greece, Hungary, Italy, Latvia, Sweden and Finland participated in a program on water examination to develop GIS applications in upper secondary school education and in-service teacher training (Johansson and Pellikka 2005).

Other European countries are also interested in the introduction of GIS into education and nowadays these countries can be easily connected via the Internet. It can be said that this is a very challenging example of connecting schools which have different languages and cultures but the same objectives, and developing programs so that students in each country can use GIS positively.

5.5 Reasons why GIS could be introduced in Finland

In Finland, after the computer environment, software, data, curricula incorporating GIS, study materials, support for in-service teachers and education for university students had been prepared, GIS was introduced into

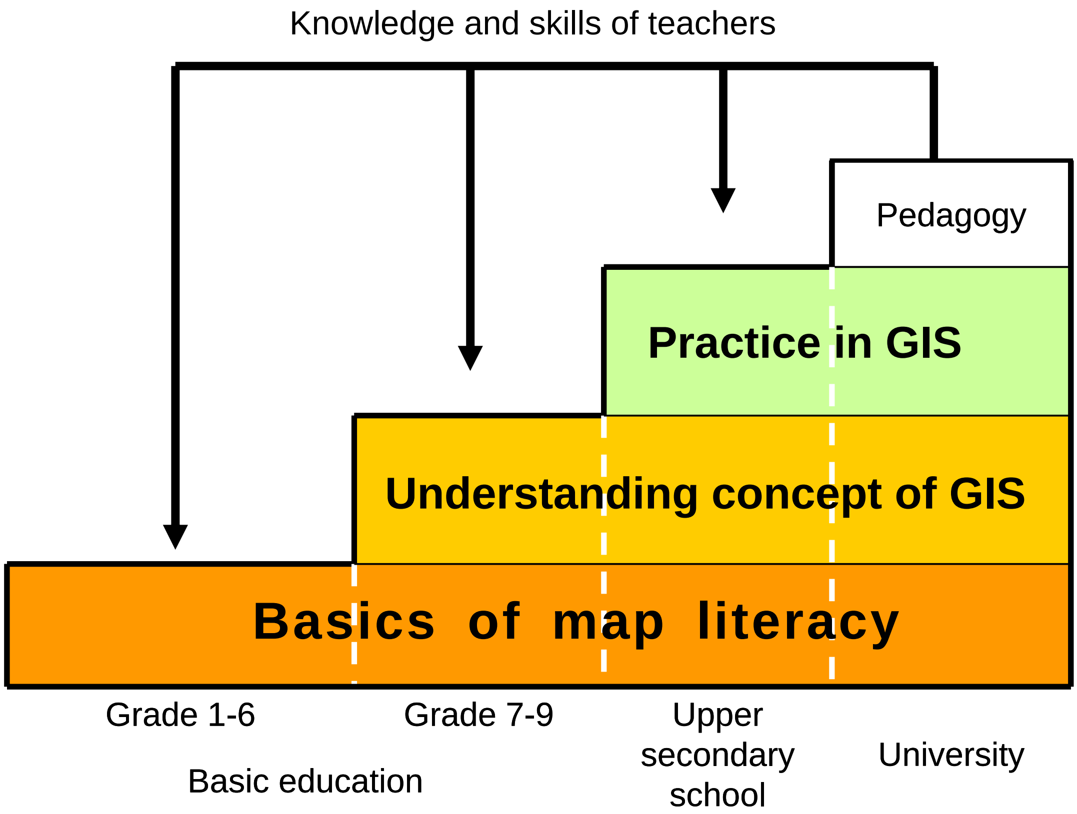


Figure 5-10 Finnish education model for introducing GIS in education

the national core curriculum.

The emphasis is on educational content to develop basic map skills for using GIS, and on human resource development such as training teachers who can use GIS and apply it in classes.

The Finnish education system provides a continuous flow from basic to higher education. This concept is reflected in the education curricula. For example, study using GIS has advanced content which is introduced after students have acquired the basic map skills and concepts to understand GIS. This means that introducing GIS is considered from a long-term perspective from basic to upper secondary education. Also, tasks which upper secondary school students actually perform in class are included in the lesson content of teacher training courses at university. Through such experience, students learn the purpose and conduct of classes. Of course, GIS is obligatory for students who want to be geography teachers. This is because the target of the teacher training courses at university is students who will return to basic education or upper secondary education as teachers with the ability to adjust to the new national core curriculum (Figure 5-10).

Also, to enable in-service teachers to conduct classes using GIS in line with the new national core curriculum, workshops on GIS are held by universities under the leadership of the FNBE and cultivation of teachers who can use GIS in class has been promoted in a very short period.

The environment surrounding GIS in Finland still faces problems in use of GIS in schools. General GIS software is expensive and schools have to buy geographic data of the country. In this respect, Japan seems to be in a more favorable position. Despite such difficult circumstances, more than 60% of teachers in Finland have already introduced GIS in class in one year since the national core curriculum came into force. These efforts of Finland present a successful case of introducing GIS and are estimable.

5.6 Conclusion

The aim of this chapter is to consider utilization of GIS in school education in Japan, and the actual use of GIS in class and the background to introducing this tool into classes in Finland, a country that has already introduced GIS into the national core curriculum.

First, a questionnaire survey to teachers in Finland showed that most of them already understand what GIS is and many of them already use GIS in class.

Consideration of the Finnish education system, education content and manner of introducing GIS in class throws light on the reasons why Finland has been able to introduce GIS in the national core curriculum and actual classes. The introduction of GIS in education was made possible by the education content including map education and development of spatial cognition in basic schools and upper secondary schools, formulation of the basics for the new curriculum such as research, teacher training and university education, the school environment in terms of computers, software, timetable scheduling and teachers, and cooperation with other countries.

Here we need to recognize that all levels of schools from compulsory to higher education are linked in some way or another. Japanese education has much to learn from the coherent Finnish education curricula from basic education to upper secondary school, designed from the viewpoint of GIS in basics of map education and building of a system to train teachers who can adjust to the new curriculum in a short time,.

The Finnish experience indicates that utilization of GIS depends on teachers' skills and their views on using this tool. To use GIS, students naturally have to be able to read maps as a basic skill for using GIS. To give students the skills to read maps, teachers must not only acquire map literacy themselves but also have experience in using GIS and applying this tool in class. The role of in-service teacher training is, therefore, essential in facilitating and enhancing the use of GIS in upper secondary education. The teachers need support in comprehending the pedagogical shift which the use of GIS brings.

Lack of curriculum support seems to be one reason for the low adoption of GIS by geography teachers in Japan. As seen in the Finnish case, the incorporation of GIS into the national core curricula has obliged schools and teachers to take steps towards learning to use GIS in the classroom. But the most important thing is that the educational content designed for developing students' map skills and fostering a multi-dimensional way of thinking utilizing GIS is included in the national curriculum standards. At the same time, to utilize GIS in education, it is vital to support teachers' development of classes in such aspects as providing content, data and ideas, and to try to keep the quality high. Training and practice in using GIS are necessary for in-service teachers and for university students as future teachers.

Notes

1) As pre-primary education, there are nursery schools (Päiväkoti). One year before entering basic school, pupils go to preschool (Esikoulu) in nursery or basic school.

2) It is possible to study in basic school to the 10^{th} grade as students' learning process.

3) In Finland, students could only get a Master's degree (Maisteri) at the time of graduation. But since 2005 it has also been possible to get a Bachelor's degree (Alempi korkeakoulututkinto, title is kandidaatti) by earning the required number of credits in 3 years.

4) Finland consists of 6 large regions (lääni) and is divided into 20 provinces (maakunta). Each province is divided into municipalities called "kunta". There were 416 municipalities as of 2007. Some municipalities are a 'city (kaupunki)'. But there are no special regulations for being a city; each municipality can decide (Kutalaki 365/1995, http://www.finl ex.fi/fi/laki/ajantasa/1995/19950365). There were 113 municipalities called cities as of 2007.

5) Perusopetuslaki (628/1998) http://www.finlex.fi/fi/laki/alkup/1998/ 19980628 (Last access: Dec. 20. 2007)

6) Lukiolaki (629/1998) http://www.finlex.fi/fi/laki/alkup/1998/19980629 (Last access: Dec. 20. 2007)

7) In Finland, the academic year starts from August. The new national core curriculum issued in 2004 started in all grades except 9^{th} grade in basic schools in 2005. Since 2006 all students study in line with this

curriculum.

8) Lahti (2000) said this ‘natural environment’ includes climate, physical, chemical and biological factors and human anatomy.

9) Topographic maps are issued by the National Land Survey of Finland (Maanmittauslaitos). There are 2 different scales: 1: 20000 (Maastokartta) and 1:50000 (Topografinen kartta).

10) “Paikkatietojärjestelmät” corresponds to GIS, although its literal interpretation is “position information system”, because “paikka” means position.

11) “kulttuurimaantiede” literally means “cultural geography,” but this word is also used to mean ‘human geography.’ So here the translation cultural (human) geography is used.

12) The terms ‘Geology (Geologia)’ and ‘earth science (maatiede)’ are not found in either national core curriculum.

13) Dr. Houtsonen and her colleagues participated in the ESRI user conference and other conferences and researched education using GIS in the United States.

14) The main universities in Finland have an education institute attached to them and provide educational programs for working people.

15) All textbooks in regional studies are written in Finnish. The Swedish versions had not yet been published as of August 2006.

16) The Minerva Action of the European Commission was directed at promoting European cooperation in the field of open and distance learning and ICT in education with a mandate for 2000-2006.

References

Akimoto, H. 1999. Kotogakko ni okeru GIS (GIS in high school). *Chiri jouhou shisutemu gakkai kouen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 8, 19-22.

Baker, Thomas R. 2005. Internet-based GIS mapping in support of K-12 education. *Professional Geographer*, 57-1, 44-50.

Butt, G., Hemmer, M., Hernando, A. and Houtsonen, L. 2006. Geography in Europe. In *Geographical Education in a Changing World: Past Experience, Current Trends and Future Challenges*, ed. J. Lidstone, and Williams, M., 93-106, Netherlands: Springer.

Cantell, H., Houtsonen, L., Jutila, H., Kankaanrinta, I., Tammilehto, M. ja Vaalgamaa, S. 2005. *Maapallo: Maailman Ympäri*. Porvoo: WSOY.

Cantell, H., Houtsonen, L., Jutila, H., Kankaanrinta, I., Tammilehto, M. ja Vaalgamaa, S. 2006. *Maapallo: Matkalle Eurooppaan*. Porvoo: WSOY.

Cantell, H., Jutila, H., Kankaanrinta, I., Tammilehto, M. ja Vaalgamaa, S. 2006. *Maapallo: Suuntana Suomi*. Porvoo: WSOY.

Fabritius, H., Kenno, P., Nowak, A. ja Ruth, C. 2006. *Lukion maantiede 4: Aluetutkimus*. Helsinki: Otava.

Fukuda, S. 2006. Kyoso yamerata gakuryoku sekai ichi: finrando kyoiku no seiko *(Shutting out competition produced the world's highest academic achievements: the success of Finnish education)*. Asahi shimbun.

Honkanen, J., Raekunnas, M., Riikonen, J., Saarivuori, M. ja Alanen, E.

2005. *Luonnonkirja 4*. Porvoo: WSOY.

Honkanen, J., Raekunnas, M., Riikonen, J., Saarivuori, M. ja Alanen, E. 2006. *Luonnonkirja 3*. Porvoo: WSOY.

Houtsonen, L. 2003. Maximising the use of communication technologies in geographical education. In *International handbook on geographical education*, ed. Gerber Rodney, Kluwer Academic Publishers, 47-65.

Ida, Y. 1995. Nyujirando ni okeru chiri kyoiku – sono ninki no yoin – (Geography education in New Zealand: the popularity factors). *Shin chiri (New Geography)*, 43-1, 1-13.

Ida, Y. 1999. Chiri kyoiku ni okeru ishi kettei shien tsuuru to shite no GIS no riyo (Use of GIS as a decision making support tool in geography education). *Chiri joho shisutemu gakkai kouen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association),* 8, 7-8.

Ida, Y. 2004. Gakko kyoiku ni okeru GIS ni yoru gakushu no ichizuketo kadai – Taiwan tono hikaku ni yoru kyoiku katei no shiten kara- (Evaluation and issues on studies with GIS in school education: from the perspective of curriculum by comparative study with Taiwan). *Tsukuba kyoikugaku kenkyu (Tsukuba Journal of Education Study),* 2, 103-119.

Itoh, S. 1999. Amerika gasshukoku no gakko kyoiku ni okeru GIS riyo no tenkai (Development of use of GIS in school education in the United States of America). *Chiri joho shisutemu gakkai kouen ronbun shu (Papers and Proceedings of the Geographic Information Systems*

Association), 8, 1-6.

Itoh, S., Ida, Y., and Nakamura, Y. 1998. Gakko kyoiku ni okeru GIS riyo-amerika gasshukoku no doko to waga kuni no kanosei (Use of GIS in school education: trends in the United States of America and possibility in Japan). *Chiri jouhou shisutemu gakkai kouen ronbun shu (Papers and Proceedings of the Geographic Information Systems Association)*, 6-2, 65-70.

Itoh, S., Yuda, M., Okunuki, K., Kizu, Y., Kawasaki, T. and Tatematsu T. 2005. The development of Cellular Phone GIS for urban surveys. In *Cities in Global Perspective: Diversity and Transition*, ed. Murayama, Y. and Du, G., IGU, 620-626.

Johansson, T. 2003. GIS in teacher education - facilitating GIS applications in secondary school geography. In *ScanGIS'2003 - Proceedings of the 9th Scandinavian Research Conference on Geographical Information Science, 4-6 June 2003, Espoo, Finland*, ed. Virrantaus, K. and Tveite, H., Department of Surveying, Helsinki University of Technology, 285-293.

Johansson, T. ed. 2006. *Geographical Information Systems applications for schools – GISAS*. University of Helsinki.

Johansson, T. and Pellikka, P. 2005. Interactive Geographical Information Systems (GIS) Application for European upper secondary schools. In *Recent Research Developments in Learning Technologies, III International Conference on multimedia & ICT’s in Education*. 505-509.

Kerski, J.J. 2001. A national assessment of GIS in American high schools. *International Research in Geographical and Environmental Education*. 10-1, 72-84.

Kerski, J. J. 2003. The Implementation and effectiveness of Geographic Information Systems technology and methods in secondary education. *Journal of Geography*, 102, 128-137.

Lahti, L. K. 2000. Ympäristökasvatuksen sekä ympäristö- ja luonnontiedon merkityseroista, In *Opettajatiedon kipinöitä: kirjoituksia pedagogiikasta*. ed. Enkenberg, J., Väisänen, P. ja Savolainen, E., 205-220. Savonlinna: Joensuun yliopisto Savonlinnan opettajankoulutuslaitos.

Löytönen, M., Toivonen, T. ja Kankaanrinta, I. 2003. *Globus GIS*. Porvoo: WSOY.

MacEachren, A. M. 2000. Cartography and GIS: facilitating collaboration. *Progress in Human Geography,* 24, 445–456.

Minamino, T and Fujii, Y. 1992. Gasshukoku chiri kyoiku gaidorain ni miru chirigakuteki mikata, kangaekata – gaidorain ni shimesareta shoto kyoiku ni okeru totatsu mokuhyo no bunseki wo toshite – (Geographical view and way of thinking in guidelines for geographic education: through analysis of the achievements in elementary education shown in the guidelines). *Shin chiri (New Geography),* 40-2, 49-58.

Mizuoka, F. 1981. Doitsu renpo kyowakoku no chiri kyoiku kaikaku (The reform of geography education in the federal republic of Germany). *Chirigaku hyoron (Geographical Review of Japan),* 54-4, 177-195.

Murayama, A. 1996. Suweden ni miru chiri kyoiku no kozo to rinen – atarashii kyoka chiri wa nani wo mezasu noka – (Structure and philosophy of geography education in Sweden: what is the aim of new geography as a subject?). *Shin chiri (New Geography)*, 44-1, 1-13.

Nakayama, S. 1986. Amerika gasshukoku ni okeru chiri kyoiku naiyo no kaizen ni kansuru doko – 1960-85 nen (Trends in improvement of education content of geography in the United States of America in 1960-85). *Hiroshima daigaku kyoiku gakubu kiyo (Bulletin of the Faculty of Education, Hiroshima University)*, 35-2, 59-69.

Nuutinen, A. M., Tolvanen, P. ja Alanen, E. 2005a. *Luonnonkirja 1*. Porvoo: WSOY.

Nuutinen, A. M., Tolvanen, P. ja Alanen, E. 2005b. *Luonnonkirja 2*. Porvoo: WSOY.

Opetushallitus 2003. *Lukion opetussuunnitelman perusteet 2003*. Helsinki: Opetushallitus.

Opetushallitus 2004. *Perusopetuksen opetussuunnitelman perusteet 2004*. Helsinki: Opetushallitus.

Opetushallitus 2006. *Suomen koulutusjärjestelmä*. http://www.oph.fi/Sub Page.asp?path=1,438,4171 (Last access: Dec. 20. 2007)

Opetusministeriö 2007. *OECD PISA survey*. http://www.minedu.fi/OPM/ Koulutus/artikkelit/pisa-tutkimus/index.html?lang=en (Last access: Dec. 20. 2007)

Ratinen, I. and Johansson, T. 2005. Teachers' opinions of the incorporation of GIS in the upper secondary schools in Finland.

International Cartographic Conference 2005: Mapping Approaches into a Changing World, July 9–16, 2005, A Coruña, Spain, CD-ROM: Theme 20: Cartography and Children, Educational Projects, Session 2.

Tani, K., Sato, T., Onishi, K., Okamoto, K. and Okunuki, K. 2002. Chugakko ni okeru chiri kyoiku yo GIS no kaihatsu to kyoiku jissen (Development and practice of GIS for geography education in lower secondary schools). *GIS : riron to oyo (Theory and Applications of GIS)*, 10, 69-78.

Tatsuoka, Y. 2002. “Mijika na chiiki” gakushu ni okeru GIS riyo: jidohanbaiki chosa wo rei to shite (Applying GIS to "local area" study in social studies : a case of studing location of vending machines). *Naruto kyoiku daigaku gakko kyoiku jissen senta kiyo (Bulletin of Research Center for School Education, Naruto University of Education)*, 17, 85-94.

Ueno, K. 1994. Igirisu no “Nashonaru karikyuramu ni okeru chiri” seiritsu ni miru chiri kyoiku kaikaku - igirisu chiri kyoiku no rekishiteki kosatsu wo tsujite - (The reform of geographical education in England caused by the establishment of *geography in the national curriculum* [England]: through the historic consideration of geographical education in England). *Shin chiri (New Geography)*, 41-4, 1-13.

Chapter 6. Conclusion: For the utilization of GIS in school education in Japan

6.1 General remarks

In this dissertation, the possibilities of using GIS in school education in Japan have been examined comprehensively from different aspects, such as understanding the nature and problems of the Japanese national curriculum standards from the viewpoint of introducing GIS into school education, the characteristics of students as future potential GIS users, the development and evaluation of Cellular Phone GIS based on users' needs and characteristics, and awareness of Finnish education as a successful case of introducing GIS into school education.

Regarding the state of GIS use in school education in Japan, the results of a questionnaire to upper secondary school teachers in the Hokuriku district revealed that most teachers have hardly ever used GIS in class.

The reasons put forward for not using GIS in class were the pressure on teachers' time and class time, the computer, network and software facilities in schools, teachers' skills in GIS and the education curriculum.

Through examination of the national curriculum standards which are legally binding on lesson content, it became clear that there is no direct mention of GIS or inclusion of study of the basics of map literacy and map skills, even though utilization of maps is emphasized. Thus, the national curriculum standards indicate that the education curricula in school education in Japan are not ready to introduce GIS yet.

The results of the surveys on knowledge of how to read and understand maps as a necessary skill for using GIS, conducted by age, showed that tendencies in map reading are based on development of spatial cognition by age and accuracy of map reading skills.

A notable difference was found in the reference points used to read maps. People who can read maps look at roads, crossings and buildings in a wider area and understand the positional relationship among them. This tendency is also observed among upper secondary school students. On the other hand, respondents who were unable to read maps accurately tended to look for point information such as names of places or landmarks. Furthermore, the number of reference points was fewer. Therefore, looking at a small number of points might cause errors in reading maps. Lower secondary school students tended to display this tendency. These results showed that the accuracy of map reading is related to the level of spatial cognition, number of reference points and experience in studying and reading maps.

The development and evaluation of GIS for fieldwork in school education were conducted by applying these findings. A series of practical exercises with Cellular Phone GIS and fieldwork using the system were carried out with the cooperation of universities, secondary schools, municipality governments and private companies. The experiment with university students proved that fieldwork with Cellular Phone GIS is more efficient than conventional fieldwork with paper maps and notebooks. Through experiments with lower and upper secondary school students in actual classes, it was confirmed that fieldwork and use of GIS, which are difficult to include in actual classes nowadays, were possible due to the effectiveness of Cellular

Phone GIS. Cellular Phone GIS helped students to do the fieldwork itself and classes after the survey went smoothly, enabling maximization of the limited time and facilities in school. Also, it was obvious that with Cellular Phone GIS students not only participated in the fieldwork, but also gained experience in considering their findings from a variety of viewpoints.

In this dissertation, Finland was taken up as the case of a country where GIS has already been introduced into school education since 2005. Most teachers in Finnish upper secondary schools which have a course on GIS understand the nature and functions of GIS and many of them have already used this tool in class.

A notable feature of geography in Finland is that geography is one of the natural science subjects, and some geography content is integrated into other natural science subjects. In such circumstances, the strategies for the introduction of GIS into Finnish education include the educational curricula which develop students' map reading skills to enable them to use GIS by themselves in upper secondary school not only in geography but also in other natural science subjects, the foundations of the new curricula such as research into the effectiveness of GIS in education, training for teachers in the new education content, improvement of the conditions surrounding GIS software and cooperation with other countries. The content of education from basic to higher education, in particular, is closely interlinked and consciously designed so that knowledge and experience which are accumulated in school education will be recirculated back to school education.

A point of uniqueness of the dissertation is that the current and expected environment of school education and GIS are considered from various perspectives such as education systems and regulations of not only Japan but also Finland, users' characteristics, development of an original GIS using mobile phones and evaluation of it by teachers and students.

The problems in introducing GIS into the education field have been discussed. In particular, the Japanese curriculum itself has not been examined in detail from the point of view of GIS. This dissertation clarified that the contents of the national curriculum standards from elementary to upper secondary school are not ready to accept GIS utilization in class. Of course, there have been some suggestions that educational content including GIS should be employed in the national curriculum standards. But it is difficult to measure how effective introducing GIS in the national curriculum standards would be or to know whether the national curriculum standards really make a difference in the situation of GIS in class. In this context, this study shows how the national curriculum standards could affect changes in teachers and classes with GIS from the viewpoint of the case of Finland. Furthermore, the Finnish case suggests important preparations that should be made for introducing GIS in education, besides the revision of the national curriculum standards. As mentioned before, geography education in Finland has not been explained in Japan other than in this dissertation. So this study will contribute much to the improvement of geography education in Japan and the utilization of GIS in school education.

Also, this dissertation revealed the methods of map reading used by pupils and students. The study showed where they made errors in map reading and how GIS could help them if GIS were introduced. Considering these findings, the dissertation developed Cellular Phone GIS, an original GIS based not only on teachers' opinions, lesson content and the computer and network environment in schools, but also on the characteristics of students such as their skills in map reading and using a combination of mobile phones and Internet connection that are familiar to students nowadays. Compared to other studies to develop GIS for education and to practice GIS, the multidimensional approach of this study on Cellular Phone GIS is estimable.

The dissertation including these experiments with Cellular Phone GIS, the recognition of issues surrounding GIS in school education in Japan and some good examples from Finland will surely contribute to the practical use of GIS in school education in Japan.

6.2 GIS in school education in Japan: Its meaning and future

This dissertation shows that the national curriculum standards and educational content, education and training of in-service teachers and university students as future teachers and development of GIS to solve the problems in classes are the key to finding a way to utilize GIS in school education in Japan.

If experience and knowledge acquired in school education are the basis for everything in life, map education and experience in using GIS in school education will provide the knowledge and skills required by people in the geospatial information society which is just around the corner. Meanwhile, through this experience of using GIS, students’ ability to think from multiple viewpoints, regarded as an important skill in today’s society, will be developed. In that sense, there is an expectation that education using GIS in schools has a social responsibility to nurture future GIS users as human resources with the skills required in society. We should not only give voice to this opinion, but also make it possible. So in this dissertation, the author has considered utilization of GIS in school education in Japan.

Through this dissertation, some problems facing Japanese school education in introducing GIS into the education field have been revealed. The present school education system provides virtually no opportunities for students to learn the basics of map literacy. The national curriculum standards emphasize effective use of maps and atlases from elementary school, but there are no units for learning about maps themselves until the end of upper secondary education.

The intellectual basis and skills to operate GIS should be fostered in primary and secondary school education. Map reading is a skill that must be learned like a language. Some people believe that we become able to read maps unconsciously, but that is not true. From this point of view, lack of map education in 12 years of school education is a major problem. If GIS were introduced in present school education, students as GIS users would have to use GIS before they had adequately developed their map skills. Under such circumstances, it is possible that they would not understand maps or the results displayed on GIS.

The Finnish case indicates the importance of curriculum support for using GIS in school education. The incorporation of GIS into the national core curriculum in Finland has obliged schools and teachers to take steps towards learning to use GIS in the classroom. And the role of in-service teacher training is essential in facilitating and enhancing the use of GIS in school education. At the same time, development of the content of lessons for cultivating map skills and applying GIS is necessary.

In addition, GIS to support classes is expected to be further improved. The results of classes with Cellular Phone GIS indicate that this system could help teachers and students to prepare classes easily and utilize lesson hours in an existing IT environment. Such benefits in improvement of the environment for time-pressed teachers and of the students' learning environment were originally anticipated when the effectiveness of GIS was discussed.

It has already been proved in the dissertation that using Cellular Phone GIS in classes allows adequate time to use lesson hours effectively and prepare classes. But it is still difficult to use this tool in school education. In-service teachers and future teachers studying in university, as the decision-makers in conducting lessons, need to understand this tool and its effectiveness. Furthermore, the introduction of GIS should be supported by the national core curriculum with which teachers have to comply. Curricula that include content to develop students' map literacy and enable them to study more effectively with GIS should be designed from primary to higher education from the perspective of the circulation of education. Thus,

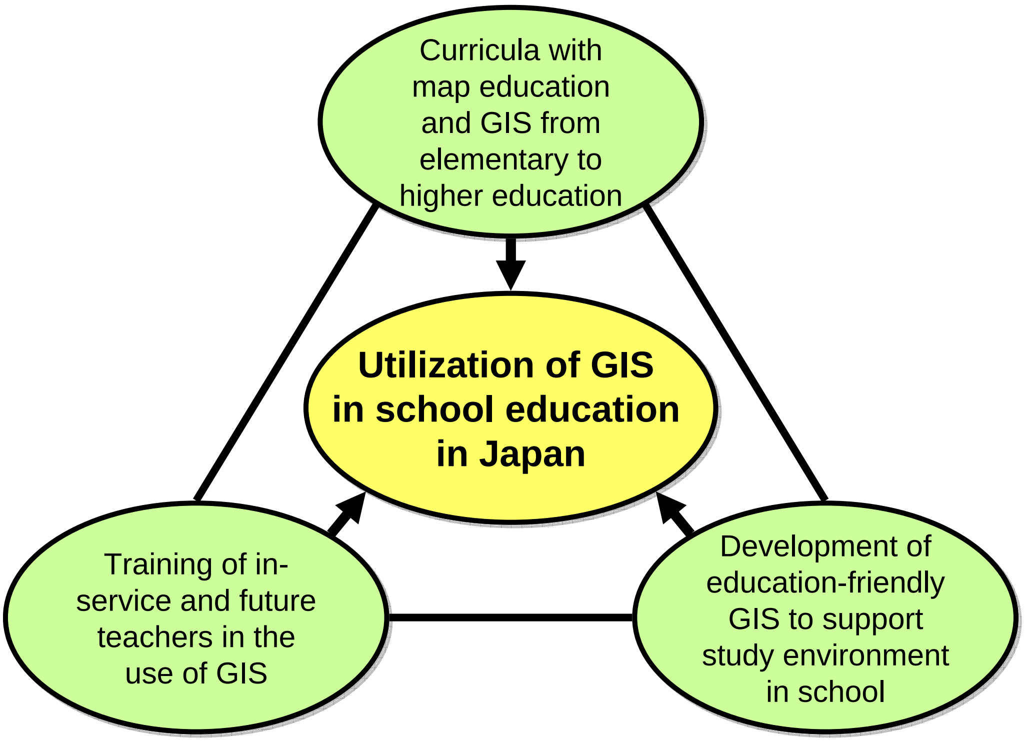


Figure 6-1 Model of introducing and utilizing GIS in school education

curricula including map education and GIS, teachers' training and development of GIS software would make it possible to use GIS in school education (Figure 6-1).

6.3 Future issues

The situation surrounding GIS in education is severe. The education curriculum is not suited to using GIS. Teachers have a passive attitude toward GIS. Even if GIS were introduced, teachers and students would have a heavy workload because of it. It would cause a burden for teachers and students and lack of time to use the functions of the software.

But GIS must be considered from a long-term perspective and a wider point of view. GIS is regarded as the next-generation information infrastructure. The age of ubiquitous GIS when it will be used by everybody is not far in the future. For this reason, it is important that future GIS users learn the basics of GIS and gain experience in GIS at school.

To introduce GIS into school education, it would be most effective if GIS were adopted in the national curriculum standards. Of course, a curriculum that includes map education and content to enable use of GIS needs to be suggested. But more important is how teachers will facilitate classes with GIS.

In this dissertation, the author was involved with some classes using GIS. To conduct classes with GIS, it is important to hear teachers' initial views and to suggest to them how and what GIS can do. Universities will be able to support teachers to design their classes using GIS. But at the same time, teachers themselves will have to consider not only course content but also the utilization of GIS. In this case, the role of universities which foster students as teachers and provide in-service teacher training will become more important. Actually, geography teachers do not solely teach geography but other subjects as well. Therefore, a cross-disciplinary approach to learning should be highlighted in the teacher training workshops.

Cellular Phone GIS needs further improvement in many points. Through this dissertation it became clear that Cellular Phone GIS can help to conduct fieldwork effectively. But some points on the usability of the Cell Phone GIS Application such as base maps, cursor motion and speed of response have been pointed out. Also, customization of the two applications is restricted and the text and database structure are fixed. Cellular Phone GIS should be improved more and should eventually be accessible to everybody. Improving such problems based on evaluation by students will make the system more useful not only in the education field but also in other cases.

The development and utilization of Cellular Phone GIS in class succeeded thanks to the cooperation of the education and private sectors. The role of universities as a bridge between the different sectors will become more important. Such cooperation will be pursued to build a better global environment in the future.

Appendices

【Appendix 2-1】Questionnaire to upper secondary school teachers on GIS in Japan [Japanese version]

学校教育における GIS に関するアンケート 2006

ヘルシンキ，フィンランド
金沢，日本
2006 年 12 月

日本の地理教員の皆様

GIS(地理情報システム)の地理教育における役割は，近年重要になってきています．ご存知のとおり，GIS はコンピュータ上でさまざまな空間データを管理，分析，視覚化するためのツールです．そしてこのデータは位置情報と結びついたさまざまな属性データからなっています．GIS を用いれば，ユーザは異なったデータを統合し，そのデータを地図として即座に見ることも可能です．以前のように GIS は大学や研究機関においてのみ使われるツールではなく，世界中の中等教育において組み込まれつつあり，アメリカ，デンマーク, ドイツなどにおいて特に中学，高等学校の段階で取り入れられています．

フィンランドにおいても，新学習指導要領において，高等学校地理の選択科目「地域研究」において GIS が導入されています．教員は生徒たちの近隣地域の調査を行う上での理解を深めるとともに，学校と情報化社会を結びつけ, コンピュータスキルとメディアリテラシーの涵養を行うツールとして GIS を用いています．また, GIS を用いる背景には，他にも生徒たちの情報通信技術(ICT)のスキルを強化するという目的もあります．日本でも，学習指導要領で「GIS」という明確な記述はないものの, コンピュータを用いた授業が推奨されています．

現在は，国の教育機関や市町村，企業などから，多くのデータや資料，ソフトなどの入手が可能です．もちろんこれらのソフトウェアやデータにはさまざまあるので，教育向けに工夫が必要なわけですが，すでに日本も含めて多くの国で学校教育において GIS を活用するための取り組みが行われており，教師や学校現場の意見やニーズについての研究，分析もみられるようになって参りました．

今回, この学校教育における GIS に関する調査は，フィンランドと日本において実施され，2007 年にその研究成果をフィンランド語，日本語，英語で発表することにしております．この質問表は，すでに約 200 名ずつ，フィンランドの地理，生物の先生方に送られています．質問は，学校や先生方が授業を行ううえで現在どのように GIS のデータ，テーマおよびソフトを用いているか，どのようなことを必要としているかということに焦点を当てています．また同時に，学校において GIS を用いることの最大の障壁は何かということを明らかにすることも考えております．より多くの先生方が回答してくださることで，学校教育における GIS の活用に向けてのより明確な方向性が見えてくるのではないかと思われます．この結果は，GIS サービスの発展，学校教育向けのデータやソフト，そして教職員研修の企画や開催に役立つことと思われます．

回答は，以下の質問表で答えていただくことになります．または，インターネット上からもお答えいただけます(http://www.helsinki.fi/maantiede/arkisto/paikkatieto/questionnaire_j.htm)．統計的な分析を行うため，ご回答いただく先生の年齢等の情報をお答えいただきますが，それ以外に個人を特定できる情報は一切伺いません．また, このアンケートによって収集したデータは，この研究以外の目的で使われることや他の機関の手にわたることも一切ありません．

アンケートの回答に要する時間は，およそ 15 分程度と思われます．締め切りは **1** 月 **25** 日とさせていただきたいと思います．

なにとぞ趣旨をご理解いただき，ご回答いただければと思います．お忙しいところ大変申し訳ありませんが，よろしくお願いいたします．

敬具

ティノ・ヨハンソン(Tino Johansson)
ヘルシンキ大学　地理学科　研究員
University of Helsinki, Department of Geography
P．O.　Box 64
FI-00014 University of Helsinki, Finland
tel.　+358 9-19151045
tino．johansson@helsinki．fi

湯田ミノリ
金沢大学大学院自然科学研究科環境科学専攻
920-1192　金沢市角間町　金沢大学
minori-y@stu．kanazawa-u．ac．jp

基本的な情報

はじめに, いくつかお答えいただく先生方についての基本的な情報をうかがいます. これは, 統計的な分析に必要なものです.

当てはまる回答を選択肢から当てはまるものを選び, ○をつけてください. また, 一覧に回答がない場合はその他として, 具体的な答えをお書きください.

1. 性別 1. 男性, 2. 女性

2. 年齢 _____歳

3. 普段使用されている言語

1. フィンランド語, 2. スウェーデン語, 3. 英語, 4. 日本語, 5. その他( )

4. 学校名 ( )

5. 学校の所在地(都道府県名および市町村名) ( )

6. 先生になられて何年になりますか？ ____年

7. ご担当科目について

7-1. 中学校で教えていらっしゃる場合

【ご担当教科】1. 理科, 2. 社会科, 3. その他

(具体的な教科名:)

7-2. 高等学校で教えていらっしゃる場合

【ご担当教科】1. 理科, 2. 地理歴史, 3. 公民, 4. 情報, 5. その他

(具体的な教科名:)

8. 担当されている学年

1. 中学 1 年, 2. 中学 2 年, 3. 中学 3 年, 4. 高校 1 年, 5. 高校 2 年, 6. 高校 3 年,

7. その他(具体的に:)

8-1. 学校全体で, 地理の授業はどの学年で教えていますか.

<u>科目名</u>, <u>学年</u>, <u>年間総時間数</u>, **<u>1 時間[1 コマ]</u>**<u>は何分</u>か, およびそれらの授業が<u>必修</u>, <u>選択科目</u>かどうかを教えてください.

9. ご自身の大学時代の専攻を教えてください.

1. 地理学, 2. 生物学, 3. その他(具体的にお書きください:)

10. ご自身の大学時代の副専攻を教えてください(あれば).

( )

<u>地理情報システムに関する知識について</u>

次に，地理情報システムに関する知識について伺います.

11. **GIS** については，すでによくご存知でいらっしゃいますか**?**

1. はい， 2. いいえ(→問 13 へおすすみください)

12. どこで **GIS** を学びましたか**?**当てはまるものに〇をお付けください

1. 大学時代に学んだ
2. 公共団体(都道府県教育委員会や教職員組合，その他公益法人など)が企画した研修で
3. 一般企業が企画したセミナーなどで
4. 独学で
5. その他(具体的にお書きください:)

13. 今まで **GIS** のソフトウェアの使用経験はありますか？

1. はい， 2. いいえ(→問 16 へおすすみください)

14. お使いになったことのある **GIS** ソフトの名前とおおよその使用年数を教えてください**.**

15. 最後に **GIS** ソフトを使われたのはいつのことですか？ ( )

16. いまの学校では授業で **GIS** は使われていますか？

1. はい， 2. いいえ(→問 22 へおすすみください)

17. 学校で使用している **GIS** ソフト名

18. どこで，どのようにそのソフトは入手されましたか？

19. 現在の学校では何年ほど**GIS**を使われていますか？ 約________年

20. どの教科で**GIS**は使われてきましたか**?**

21. 学校内で，何人の先生が**GIS**を使っていらっしゃいますか**?**

1. 1 人， 2. 2 人， 3. 3-5 人， 4. 6-10 人， 5. 10 人以上 6. わからない

22. ご自身でも個人的に **GIS** を教育のために使っていらっしゃいますか**?**

1. はい， 2. いいえ(→問 26 へおすすみください)

23. GISを教育で使われる主な目的は何ですか？当てはまるものを以下から選び，その中で大切と思われるものから順に1から番号をお付けください．

( ) 授業で地図を表示する
( ) レイヤーを用いて新しく地図を作成するため
( ) 属性データの視覚化
( ) 属性データの作成および管理
( ) GIS ソフトの操作を学ぶ
( ) 探求学習
( ) 空間的な思考を身に付けるため
( ) 統計データ分析
( ) その他(具体的にお書きください:)

24. 教育のために使うデータはどのようなものですか．当てはまるものを以下から選び，その中で最も使っているものから順に1から番号をお付けください．

( ) 市販の GIS データ(店舗で購入)
( ) 市販の GIS データ(インターネットで購入)
( ) 市販の GIS データ(教科書などの本に添付されているもの)
( ) 加工が可能な GIS データ(政府や自治体が作成したもの)
( ) 自身で作成した GIS データ
( ) 教員同士のネットワークで共有されているデータ
( ) 学校で提供しているフリーの GIS データ
( ) 地方自治体が提供するフリーGIS データ
( ) インターネット上のフリーGIS データ
( ) その他(具体的にお書きください:)

25. それら使っているGISデータセットは，どこで，どのように入手されていらっしゃるのでしょうか．具体的に，詳しく教えてください．

26. GIS を授業で使う最大の利点はなんですか？

27. GISを授業で使うにあたって最も問題だと思われることは何ですか？

28. インターネット上で入手可能なフリーのGISソフトやWebGISのサイトを授業でお使いですか？

1. はい， 2. いいえ(→問 30 へおすすみください)

29. そのソフトやサイトをどのようにお使いですか．ソフトやサイト名もあわせて教えてください．

30. 個人的にインターネット上のフリーの**GIS**用データをお使いですか？

1. はい， 2. いいえ(→問 32 へおすすみください)

31. どのようなフリーの **GIS** データを授業でお使いですか，簡単に説明してください．
もしよろしければ，そのサイトの **URL** も教えてください．

32. **GIS** 教育のために週何回インターネットを使いますか？

1. 1 回， 2. 2 回， 3. 3 回， 4. 4 回 5. 毎日

33. **GIS**は高等学校の地理教育に役に立つとお思いですか？

1. はい， 2. いいえ

34. 学校教育における **GIS** はどのような学習形態を支援するとお考えですか？

1. 個人学習 2. グループワーク，3. 講義，
4. 個人学習とグループワーク
5. 個人学習および講義
6. グループワークおよび講義
7. これら 3 つとも

GISに対する意見

ここからは，ご自身の GIS に対する意見などを伺います．各質問について，5 つの選択肢(そう思う，ややそう思う，ややそう思わない，そう思わない，分からない)からお選びください．

35． 少なくとも **1** つの **GIS** ソフトについて，自分は授業で使えるだけの基本的な操作は習得している．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

36． 多くのデスクトップ **GIS** ソフトウェアは授業で使える適当な機能を有していると思う．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

37． 多くのインターネット上の **GIS** サイト**(WebGIS** など**)**は教育現場で使うにあたり，適当な機能を有していると思う．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

38． 学校のある地域に関する十分な **GIS** データがインターネット上から取得可能である．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

39． 授業の目的にあった，自分で加工することなくすぐに使えるさまざまな種類の **GIS** データの入手は可能である．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

40． **GIS** ソフトは，主題図が作れるので，教育現場で活用できる．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

41． **GIS** の利用は，探求学習で役に立っている．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

42． **GIS** ソフトは難しすぎて使えない．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

43． **GIS** ソフトは地域分析を行うことが出来るので，教育現場で使える．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

44． **GIS** ソフトは，自分たちの調べたことが視覚化できるので，授業で使える．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

45． **GIS** ソフトでは，地図上のオブジェクトを選択したり分類したり出来るので，教育現場でも活用できる．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

46． 授業における **GIS** の活用は，生徒たちの問題解決能力を向上させる．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

47． 授業での **GIS** の活用は，生徒たちの空間的思考能力を向上させる．
1. そう思う 2. ややそう思う 3. ややそう思わない 4. そう思わない 5. わからない

48.　GIS の利用は学校での地理教育に付加価値をもたらすと思う.

1. そう思う　2. ややそう思う　3. ややそう思わない　4. そう思わない　5. わからない

49.　GIS は学際的な授業に役に立つと思う.

1. そう思う　2. ややそう思う　3. ややそう思わない　4. そう思わない　5. わからない

50.　GIS の教育利用について, 一番の強みは何だと思われますか**?**

51.　GIS の教育利用で, 一番弱い点は何だと思われますか**?**

52.　GISソフトの教育利用に向けて現在必要と思われるものを以下より **4** つ選び, その中で重要と思われる順に **1** より番号をお付けください.

GIS ソフトの教育利用のために, 必要だと思うものは:

(　) さまざまな縮尺での地図学習

(　) 地図上での距離の測定

(　) 地図上にテキストが書き加えられる

(　) 紙に地図が印刷できる

(　) バッファ表示が出来る

(　) 地図上のオブジェクトの色を編集できる

(　) 地図上での面積の測定が出来る

(　) 地図の立体化

(　) 属性データの分析

(　) 異なる地図レイヤーや主題図をオーバレイできる

53.　GISソフトを教育現場で使うために現在必要と思われるものを以下より **4** つ選び, その中で重要と思われる順に **1** より番号をお付けください.

GIS ソフトを教育利用するにあたり, 必要だと思うことは:

(　) 地図上のオブジェクトの位置を元にクエリが作成できる

(　) 地図上のオブジェクトの属性を元にクエリが作成できる

(　) 主題図が作れる

(　) 点や線, ポリゴンを地図上に描ける

(　) 自分の作成したデータや他から入手したデータをすでにある属性データテーブルに統合が可能

(　) マップオブジェクトの統合や消去ができる

(　) マップオブジェクトの形体が編集可能

(　) 図や表の作成

(　) 異なる地図レイヤーや主題の統合および視覚化

(　) 学校で集めた情報を地図にすること

54. GISを用いた主題図の作成のために必要と思われるものや機能を以下より 4 つ選び，その中で重要と思われる順に 1 より番号をお付けください．

GIS で主題図を作成するにあたって必要と思われるものは:

( ) 縮尺
( ) 方位記号
( ) 凡例
( ) 統計地図
( ) 写真やビデオクリップ
( ) テキスト(文字)
( ) 階級区分図
( ) ドットマップ
( ) さまざまな地図記号
( ) 異なったデータ区分の方法

55. 授業で最も使うと思われるGISデータの種類を以下より 4 つ選び，その中で重要と思われる順に 1 より番号をお付けください．

GIS を使った授業を行うに当たって，特に必要だと思うデータの種類は:

( ) 学校周辺のデータ
( ) 学校のある市町村に関するデータ
( ) 都道府県レベルのデータ
( ) 国に関するデータ
( ) 近隣市町村に関するデータ
( ) 近隣の都道府県のデータ
( ) 近隣各国のデータ
( ) 大陸レベルのデータ
( ) 連邦制国家レベル
( ) 世界中の国々に関するデータ

56. GIS を使った授業について，考え，アイデアや感想をお持ちでしたら，お聞かせください．また，GIS を使ったことがないという方でも，何かご意見がおありでしたらお聞かせください．

ご協力ありがとうございました!!!

minori-y@stu. kanazawa-u. ac. jp

【Appendix3-1】Questionnaire on spatial cognition and geographic information

2004 年 6 月 14 日

空間認知と地図情報に関するアンケート

1　自分のいる位置が地図上でわかりますか？

1-1　別紙の地図１をみて、自分のいるところに●印をつけてください。

1-2　以下にあげる学校内の建物の番号を地図に記入してください。

①附属中央図書館
②大学会館
③総合メディア基盤センター

1-3　1-1、1-2 で自分の位置や建物の位置を地図上で決定したときに考慮にいれた要素は何ですか。それぞれに当てはまるものに〇をつけ、特に重視した要素に◎をつけてください。

決定した理由	自分の位置	①図書館	②大学会館	③メディアセンター
a. 建物の形状				
b. 他の建物や目標物、特定の場所との位置関係 (基準とした建物名や目標物、場所などの位置も記入)				
c. 他の建物や目標物、特定の場所との距離 (基準とした建物名や目標物、場所などの位置も記入)				
d. 方角・方向 (基準とした建物名や目標物、場所などの位置も記入)				
e. 道路の形 (基準とした道路の名がわかれば記入)				
f. その他				

* b、c、d、e の答えは、地図に直接記入してもらってもかまいません。その場合は、「①-b」などというように、分かりやすく書いていただきますよう、お願いいたします。

1-4　この地図と関連させて、学校の建物や風景などを思い浮かべることができますか。

１．はっきり思い浮かべられる　２．やや思い浮かぶ　３．あまり思い浮かばない　４．全然思い浮かばない

2　「地図」とあなたの関係について教えてください。

2-1　地図上で自分のいる場所を特定することは

１．非常に容易　２．やや容易　３．やや困難　４．非常に困難

2-2　知らない土地(知っている土地においても)の地図を見て、指定された場所に行くことは

１．非常に容易　２．やや容易　３．やや困難　４．非常に困難

2-3　地図を見るときに、地図上でよく参照するものはなんですか。あてはまるものに〇をつけて下さい（複数回答可）。特に重視するものには、◎をつけてください。

1.　道路の形状
2.　道路の位置
3.　交差点の形
4.　交差点の位置
5.　目印となる建物の形
6.　目印となる建物の位置
7.　地区（道路に囲まれたブロック）の形状
8.　地区の位置
9.　地点間の距離
10.　方位
11.　地図に書いてある地名
12.　地図記号
13.　その他（　　　　　　　　　　　　　　　　　　　　　　　）

3　あなた自身について教えてください。

年齢　＿＿＿＿＿歳
性別　男性・女性
学校に来てからの年数　＿＿年＿＿ヶ月
学校に来る頻度　＿＿＿＿回／週
学校に来る交通手段　自転車・徒歩・バス・自動車・バイク・その他（　　　　　）
学校内でよく行く場所を教えてください（　　　　　　　　　　　　　　　　　　）

＊　今後、聞き取り調査を行う際、ご協力いただきたいと考えております。よろしければお名前、ご連絡先をお教えください。
お名前＿＿＿＿＿＿＿＿＿＿＿＿＿＿　メールアドレス＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

どうもありがとうございました。

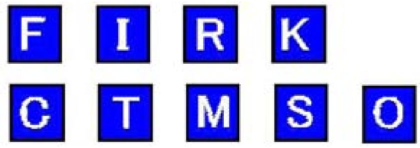
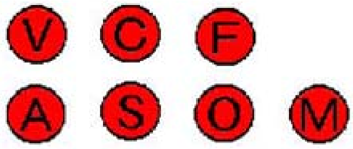
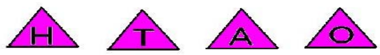
【参考】1-2　学校内の建物（写真）

①附属中央図書館


②大学会館


③総合メディア基盤センター


【Appendix 4-1】 Categories and icons for land use survey in university and lower secondary school (Cell Phone GIS Application and PC Viewer)

	Classification		Subclassification	Icons
1	Office	F	Finance (Banks and Securities)	
		I	Insurance	
		R	Real estate	
		K	Construction	
		C	Commerce (wholesale/retail), eatery	
		T	Transportation and	
		M	Electricity and gas	
		S	Service	
		O	Others	
2	Store (wholesale/ retail)	V	Various goods	
		C	Textiles, clothing, personal items	
		F	Food and beverages	
		A	Cars/ Bicycles	
		S	Furniture, fixtures, machinery	
		O	Others	
		M	Mixed store (mainly wholesale/	
3	Shop (eatery)	R	Restaurant	
		C	Cafe	
		B	Bar	
		O	Others	
		M	Mixed store (mainly eatery)	
4	Shop (service)	C	Laundry	
		B	Barber	
		R	Lease of goods	
		O	Others	
		M	Mixed store (mainly services)	
5	Accommodations/ amusement	H	Hotel	
		T	Theater	
		A	Pachinko/ Game arcade	
		O	Others	
6	Public office/ Education/ Welfare	P	Government/ Public office	
		U	Higher education institution	
		S	Elementary/ secondary school	
		K	Kindergarten/ preschool	
		L	Library/ community center	
		T	Temple/ shrine/ church	
		H	Hospital/ clinic	
		A	Home for elderly people	
		O	Others	
7	Residence	R	House	
		C	Apartment	
		O	Others	
8	Other (with buildings)	D	Workshop/ factory	
		S	Warehouse/ garage	
		V	Vacant house	
		O	Others	
9	Other (without buildings)	P	Park/ green space	
		V	Vacant lot/ parking lot	
		A	Farmland	
		O	Others	

【Appendix 4-2】Teaching plan: Whole unit

実験授業の単元計画（指導と評価の計画）全９時間予定
テーマ　玉村の新旧商店街の秘密を GIS を使って調べよう。
ねらい　携帯電話GIS を核として、GIS ソフトを組み合わせて（CrossGIS）調査することにより、見慣れた身近な地域から再発見をする。
実施クラス 玉村南中学校　選択社会科前期選択者　１７名

過程	Ｎｏ学習活動／○ねらい／・内容（時数）	評価の方法[具体の評価規準]
つかむ ４時間設定	１，選択社会についてのオリエンテーション（１時間） ・今回は１年生の時に学習した「身近な地域」の発展として、携帯電話GISを用いた調査活動を行い、コンピュータを用いて発表することを伝える。 ・グループ分け、調査地域確定、使用するGISについて写真等を使って説明する。	・意欲的に活動に取り組めたか。[意欲・観察] ・これから選択社会で学習する内容を理解できたか。[知識・観察]
	２，視点の設定、Google Earthを使ってみよう（１時間） ○調査の視点を設定しよう（20分）詳細は展開へ ・１年時に社会科の時間に紙地図を使って分布図を作製して身近な地域を学習したことを振り替えさせる。そして、発展学習として身近な地域を学習することを伝える。また、１年時に地図のきまり、読図等の基本的なことは学習済みなのでここでは学習しない事も伝える。 ・グループごとにフィールドワークするに当たって何を見てくるか視点を設定することを伝える。 ○Google Earthの操作・活用しよう（30分） ・モニター（OHC）による解説の後、プリントの課題に沿って　Google Earthの操作方法を理解するようにする。 ・調査地域のバーチャルツアーを行い、下見をすることができたか。	・フィールドワークをするための視点を考えられたか。[表現・観察]
	３，フィールドワークの準備１（１時間） ○フィールドワークでの仮説を立てる（30分） ・フィールドワークをするに当たって、見学してくるに当たっての仮説を考える。 旧商店街の方が、道幅が狭いだろう→昔は車がなかったから 大型店は新商店街の方に多いだろう→駐車場が必要だから 飲食店は新旧両方の商店街にあるだろう　等 ○ネッチケットについて学習しよう（20分） ・携帯電話GISを用いてフィールドワークを行うので、携帯電話についてのネチケットについて学習する。 ・アンケート、ワークシート、参考事例を用いる。	・フィールドワークをするに当たっての仮説を設定することができたか[思考・判断、プリント]
	４，フィールドワークの準備２（１時間） ○携帯電話GISのGeoshotを使ってみよう。 ・グループに１台ずつ携帯電話GISのGeoshotを渡し、実際に触れてみて操作方法を学習するようにする。 ・教室内でグループごとに実際にログイン、縮尺変更、登録、修正、ブックマーク登録等の操作を体験する。（事前シミュレーション）	・Geoshotをグループで体験し、操作方法を理解できたか。 [理解・チェック表]
追究する ３時間設定	５，フィールドワークに出かけよう。（２時間） ○玉村町の新旧の商店街をグループごとにフィールドワークを行う（２時間）　詳細は展開を参照 ・グループに分かれて仮説に沿って商店街を調査してくる。（オセロゲーム方式） ・地域を観察し気がついたことを携帯電話でメモする。 ・調査するに当たって、携帯電話GISのみ携帯し、１年時のように地図、デジカメ、メモ帳等を使った調査方法は行わない。 ・いつから店が営業を行っているのかインタビューする。 ・安全には特に注意するようにする。	・安全に留意してグループでフィールドワークができたか [意欲・観察]
	６，Google Mapsで考察する（１時間） ・Google Mapsの基本操作を習得する。 ・Google Mapsの時代レイヤと商店のアイコンを観察して、見慣れた地域から再発見する。	・時代レイヤ、商店のアイコン等を見て地域から再発見することができたか。[技能・表現、観察]
まとめる ２時間設定	７，調査結果をまとめ、発表する。（２時間） ○調査結果のまとめ（１時間）「玉村町新旧商店街再発見」等のタイトルで、どんなことが明らかになったか、プレゼンテーションソフト（パワーポイント）とGoogle Mapsを活用してまとめる。 ・集めた様々な資料を活用して、他に人にもわかりやすくまとめるように工夫してまとめる。	・地域調査した結果をまとめられたか。[表現・観察]
	○発表（１時間）・グループごとに短時間で調査してきたことを分かりやすく伝えるようにする。 ・他の人から出された質問や疑問に対して、真摯な態度で聞き自分の調査を深めるようにする。 ・自分でまとめたものを友だちに発表し理解を深める。 ・自己評価カードに学習をふり返っての反省と評価を行う。	・発表の仕方など図化するなどの表現力を工夫して発表できたか。 [表現・自己評価]

【Appendix 4-3】Lesson 2: Teaching plan with Google Earth

1　ねらい
調査地域を確認後、フィールドワークにおけるテーマ設定を行う。その後、Google Earth の操作を学び、調査地域をバーチャルツアーで下見をする。

2　準備
教師→Google Earth のインストール、
テーマ設定・Google Earth の操作・活用のプリント
生徒→筆記用具

3　場所　コンピュータ室

4　展開

学習活動と生徒の意識　主な発問	時間	支援および留意事項	具体の評価・方法等
1，①本時の学習内容を知る[つかむ〉 ・今日は玉村町の商店街をフィールドワークするに当たってのテーマとGIS慣れとしてGoogle Earthを使ってバーチャルで下見をしてもらいます。 ②調査する地域を地図にて確認する。 ・それぞれのグループでテーマが決まったところは発表してください。 ③事前にアンケートのプリントを配っておき、玉村町の新旧の商店街でどのようなものを調査してきたいか書かせておく。	15	①玉村町の新旧商店街のイメージがつかみづらい思われるので、教師側で事前にフィールドワークして撮影した写真をパソコンの画面に何枚か提示する。 ②家型の入った白地図を配り、出発点、到着点、新旧の商店街の境目、新旧商店外地区を確認する。 ③テーマを発表できないこともあるので教師側で事前にテーマの候補について考えておく。 例 飲食店、歴史的な建物、生活サービス、空き地、田畑、閉店している店等	・意欲的に学習に参加し、グループの話し合いテーマ設定を行うことができたか[意欲・表現・観察]
2，課題解決に向けて追究する[追究〉 ④Google Earthの操作し調査対象地域を上空から観察する。 ・Google Earthを立ち上げて、プリントの流れに沿って操作方法を伝えるのでモニターを見てやってみてください ⑤Google Earthの画面にポイントなる地点に目印を打つ。 ・玉村八幡宮（出発点)、下新田信号（新旧商店街境目)、田中生コン（終点）に目印を打ってください。できたらGoogle Earthの場所→再生をクリックして調査地点を空から確認しましょう。 ⑥バーチャルツアーを行う。 ・今度は地図をバードビューにして、鳥になったつもりで調査範囲をバーチャルツアーで下見をしよう。	25	④Google Earthの操作の仕方は、教師側でモニター画面を通じて伝達し「習うより慣れよ」式でグループの仲間と遊びながら操作方法を学習していくようにする。 ・わからない生徒は友達に聞くか挙手して先生を呼ぶように伝える。 ⑤この時点で分からない生徒は、グループの友達、教師の順に聞くようにさせる。 ⑥操作パネルの操作を習得させるために、拡大・縮小、地図の角度、方角を調整しながらバードビューでバーチャルツアーを行わせる。	・Google Earthの操作方法を習得し、グループで協力してバーチャルツアーをすることができたか[技能・表現、机間巡視・プリント]
3，[まとめ・評価〉 ⑦今日の学習を評価する。 ・今日の学習しての感想・意見・評価を評価カードに記入してください。	10	⑦特に感想・意見は詳しく書くようにさせる。	・本日の学習を行っての感想・意見・評価を記入できたか。[表現・発表、プリント評価カード]

【Appendix 4-4】Lesson 4: Teaching plan: Preparation for fieldwork and operation of the Cell Phone GIS Application

１　ねらい
・フィールドワークの前段階として、調査教材の Geoshot の操作方法をグループごとに習得する。
・実際に調査するする地点を事前に分かる範囲で登録しておき、当日の調査活動の時間を短縮できるようにする。

２　準備
教師→Geoshot アプリのインストール済み携帯電話３つ以上、OHC
Geoshot の操作・活用のプリント、本時の評価プリント、インタビューひな形
生徒→フィールドワークメモ（班長）、調査地区地図詳細（調査地点の番号、名称、住所入り）、全体地図（調査地点分け入り）、筆記用具、色鉛筆

３　場所　コンピュータ室

４　展開

学習活動と生徒の意識　主な発問	時間	支援および留意事項	具体の評価・方法等
１，本時の学習内容を知る〈つかむ〉 ①授業の内容を知る ・今日は玉村町の新日の商店街をフィールドワークするに当たって使用する携帯電話GIS（Geoshot）の操作方法について説明したあと、実際に地図を見ながら事前登録してもらいます。 ②OHCを使ってGeoshotの操作方法をモニターに写し生徒は見ながら学習する ・グループごとにGeoshotにログインしてプリントに沿ってやってみて下さい。分からないときは先生を呼んで下さい。	10	①本日の学習課題が２つをしっかりと理解できたか。 ②モニターを見ながら確認する。 学習する操作方法 縮尺変更、詳細確認、登録、 修正、ログオフ ※当日OHCが使えなければ生徒を集めて行いたいと思います。	・意欲的に学習に参加し、Geoshotの操作方法について理解できたか〈意欲・理解・観察〉
２，課題解決に向けて追究する〈追究〉 ③事前にチェックしてある調査対象の店舗をGeoshotを操作して登録してみる。 ・Geoshotを使って当日調査する店を探して登録してみて下さい。 事前登録→レイヤ、大分類、小分類、店舗名、 現地にて登録→写真、メモ、階層、 事後調査→間口、奥行き	30	③この時Geoshotの操作方法を覚えると共に、調査地点を事前に登録しておく。実際のフィールドワークでは調査地点の位置、店舗名の確認、写真撮影、階層、メモを入力するだけにして煩わしい位置入力等の時間を短縮する。（事前ｼｭﾐﾚｰｼｮﾝ） ・わからない生徒は友達に聞くか挙手して先生を呼ぶように伝える。 ・３人で順番に操作するようにする。 ・調査地点にあう大分類、小分類があるか確認する。ない場合は教師に言う。	・Geoshotの操作方法を習得し、調査地点の事前登録ができたか〈技能・表現、机間巡視・プリント〉
３，〈まとめ・評価〉 ④今日の学習を評価する。 ・今日の学習しての感想・意見・評価を評価カードに記入してください。	10	④特に感想・意見は詳しく書くようにさせる。 ・評価はそれぞれ5段階で評価する。	本日の学習を行っての感想・意見・評価を記入できたか。〈表現・発表、プリント評価カード〉

【Appendix 4-5】Lesson 5: Teaching plan for fieldwork with Cell Phone GIS Application

1　ねらい
　グループごとに携帯電話 GIS（Geoshot）を使って、玉村町の新旧の商店街を安全に注意してフィールドワークする。
2　準備
　教師→Geoshot６台　　　生徒→帽子、かさ等
3　場所　玉村町役場→玉村町新旧商店街（地図参照）
4　展開

学習活動と生徒の意識　主な発問	時間	支援および留意事項	具体の評価・方法等
1，本時の学習内容を知る[つかむ〉 ①今日の課題を確認する。 ・これからフィールドワークを行います。調査地域、携帯電話の操作、持ち物の確認をしてください。 ②準備ができたところは調査地域にグループごとに移動する。 ・特に交通事故に注意して調査活動に出かけてください。	10	①特に、携帯電話GISの操作方法をもう一度グループで確認させる。途中で操作方法が分からなくなったときは携帯電話で教師に連絡する。 ・持ち物とグループでの係、終了時間等も確認しておく。 ②交通事故等に特に注意させて出発させる。	①今日の学習の課題を理解できたか[理解・観察]
2，グループごとに調査地点に行きテーマに沿って追究活動をする[追究〉 ③グループごとにフィールドワークを行う。	75	③教師は調査地域の中心地点の下新田信号でグループの確認を行う。 ・早く調査が終わってしまったグループは役場でアンケートを記入する。遅くなるグループは必ず連絡する。 ・携帯電話GISで写真、属性データメモを入力する。 ・インタビューを行うときは相手に失礼のないように心がけさせる。	③グループで協力してテーマに沿って意欲的に調査活動が行えたか。[意欲・観察]
3，本時の学習を評価する[評価〉 ④調査を終えての感想等を記入。 ・調査が終えたら、プリントに行ってみての意見感想等を記入してください	15	④行ってみての評価を５段階で記入した後、なるべく詳しく意見感想等を記入するようにさせる。	

【Appendix 4-6】　Cell Phone GIS Application manual for students

今日のフィールドワークマニュアル

大事なこと、フィールドワークをするときは、紙の地図やメモ帳を持たない。

流れ
１，登録してあるお店の修正練習を役場前で行う。
２，フィールドワークにでたら→
①建物名や、どんなお店か（大・小分類)、お店がいつできたかを確認する。(いつできたかは、お店の人（だめなら近くの人）にインタビューする)。
②それらが、携帯電話のなかのものと違う場合、修正する。
③さらに、階数、写真、メモを携帯電話に入力する。

１，登録してあるお店の修正登録の仕方　事前練習

時代レイヤが同じ時 修正の仕方のみ	時代レイヤを修正するとき ①登録の仕方と②削除の仕方
情報修正・入力（属性情報） Menu→修正→属性情報→建物名を確認→大分類・小分類を修正→階数、写真、メモを入力→決定→ｱｲｺﾝを確認	・考え方→登録してあるアイコンの上方に新しいアイコンを登録し、前のアイコンを削除する。
店の場所を修正（図形情報） Menu→修正→図形情報→移動したい場所で”＋”を押す→移動→ｱｲｺﾝ・場所を確認	①Menu→登録→正しいレイヤ→登録済みアイコンの上方に登録→大分類・小分類、階数、建物名、写真、メモを登録→決定→Yes ②Menu→削除→消したレイヤ→右下の削除を押す→Yes→ｱｲｺﾝ確認

半分位修正、修正終了したら他のグループの途中経過を見てみよう！！

店の周りの様子（隣の店、前の道路、店の周りのこと）
・あなたがたが感じたこと（古そうだ、間口が狭い、等）
・メモった人の名前
※困ったら、終わったら先生に電話　090-****-****

【Appendix 4-7】Lesson 7: Teaching plan: Looking at the results

1　ねらい
Geoshot を使ってフィールドワークで地域から集めてきた情報を、今度は Google Maps を使って時代レイヤ、アイコンなどの属性データ等を考察し、見慣れた地域から再発見をする。

2　準備
教師→Google Maps 考察用プリント　　　生徒→筆記用具

3　場所　コンピュータ室

4　展開

学習活動と生徒の意識　主な発問	時間	支援および留意事項	具体の評価・方法等
1，本時の学習内容を知る[つかむ〉 ・今日はGoogle Mapsの操作方法を学習した後、６月１０日に行ったフィールドワークの結果をGoogle Mapsを使って考察してもらいます。 ②Google Mapsの操作方法を学習する。 ・プリントの指示に従い、Google Mapsを操作してみて下さい。	10	①今日の学習予定を生徒に伝える。 ②生徒機とモニターディスプレーを使ってGoogle Mapsの基本操作を教師側で示す。その後、生徒はGoogle Mapsを起動し、基礎的な操作をプリントに従い習得する。 起動、拡大・縮小、移動、 地図の表示切り替え等	・意欲的に学習に参加し、今日の学習課題が理解できたか。[意欲・理解・観察]
2，課題解決に向けて追究する[追究〉 ③Google Maps操作し、ABCのレイヤすべてを表示し考察する。 ・ではこれからGoogle Mapsを使ってフィールドワークしてきたことを考察してもらいます。 ④Ｃレイヤ（戦前）のみを表示して考察する。 ・Ｃレイヤ（戦前）のみ表示して、ここから何か分かることを書き出してみて下さい。後で発表してもらいます。 ⑤ＡＢＣのレイヤを組み合わせて考察する。 ・Ａ（平成以後）、Ｂ（戦後昭和）Ｃ（戦前）のそれぞれのレイヤを１枚でも２枚以上でもいいですから重ねてみて、そこから、ここから何か分かることを書き出してみて下さい。後で発表してもらいます。	30	③すべてのレイヤを考察しての意見を挙手にて聞いてみる。ここでは、プリントに意見を書いたりしない。 ・考察するときは調査地点全体を大観できるように画面設定をさせる。その後、拡大して情報を得るようにさせる。 ・わからない生徒は友達に聞くか挙手して先生を呼ぶように伝える。 ④Ｃレイヤ（戦前）が一番アイコンの数が少ないのでまずこれから始めるようにさせる。 予想される意見 ・店は例幣使街道のみ。 ・赤丸のアイコンが多い。等 ⑤予想される意見 ・Ａレイヤのみ→前橋新町線にも店ができてきた。アイコンの種類が増えてきた等 ・ＢレイヤとＣレイヤ→ほとんどの店が例幣使街道にのみある。前橋新町線にはまだ店はほとんどない等。	・Google Mapsの操作方法を習得し、レイヤを重ねたり、はずしたりすることにより調査地域を考察することができたか。[技能・表現、机間巡視・プリント]
3，[まとめ・評価〉 ⑥今日の学習を評価する。 ・今日の学習しての感想・意見・評価を評価カードに記入してください。	10	⑥特に感想・意見は詳しく書くようにさせる。	・　本日の学習を行っての感想・意見・評価を記入できたか。[表現・発表、プリント評価カード]

【Appendix 4-8】 Categories and icons for land use survey in upper secondary school (Cell Phone GIS Application and PC Viewer)

Main classification	subclassification	category	Sub-subclassification	management		Icons
				Good	Poor	
Agricultural land use	Mulberry fields	LK	Mulberry height -1m			LK MK HK
		MK	Mulberry height 1-2m			
		HK	Mulberry height 2+m			
	Normal fields	EG	Some mulberry			EG NG
		NG	No mulberry			
	Fruit farm	ESF	Single fruit with mulberry			ESF ECF NSF NCF
		ECF	Multi fruit with mulberry			
		NSF	Single fruit without mulberry			
		NCF	Multi fruit without mulberry			
	Other perennial crops	ESO	Single crop with mulberry			ESO ECO NSO NCO
		ECO	Multi crops with mulberry			
		NSO	Single crop without mulberry			
		NCO	Multi crops without mulberry			
Negative land use	Waste land	EW	Some mulberry			
		NW	No mulberry			
	Forest	EC	Conifers with mulberry			EC NC EB NB EM NM
		NC	Conifers without mulberry			
		EB	Broadleaf with mulberry			
		NB	Broadleaf without mulberry			
		EM	Conifers with mulberry			
		NM	Conifers without mulberry			
Urbanized land use	Residential use	H	House			H Hα C Cα F V R B
		Hα	House＋α			
		C	Apartment			
		Cα	Apartment＋α			
	Commercial use	F	Office			
		V	Shop (Wholesale/ retail)			
		R	Restaurant			
		B	Shop (Service)			
	Factory	D	Factory			D S PP NP CP GP O
		S	Storage of materials			
	Parking lot	PP	Paved			
		NP	Unpaved			
	Park	CP	For children			
		GP	For general use			
	Other	O	Others			

【Appendix 5-1】Questionnaire to upper secondary school teachers on GIS in Finland [Finnish version]
URL: http://www.helsinki.fi/maantiede/arkisto/paikkatieto/questionnaire.htm

Opettajien paikkatietokysely 2006

Helsingissä 24.5.2006

Hyvä opettaja

Paikkatietojärjestelmien (Geographical Information Systems) asema yliopistoissa toteutettavassa maantieteen opetuksessa ja tutkimuksessa on vahvistunut merkittävästi viime vuosina. Paikkatietojärjestelmät ovat tietokoneavusteisia alueellisen (spatiaalisen) tiedon tallennus-, analysointi- ja visualisointijärjestelmiä, joissa koordinaatein paikannettuun sijaintitietoon voidaan yhdistää monenlaisia rekisteritietokantoja eli ominaisuustietoja taulukkomuodossa. Paikkatietojärjestelmien avulla voidaan nopeasti yhdistää eri lähteistä hankittuja aineistoja ja havainnollistaa ne karttapohjalla. ks. esim. paikkatiedon perusteet

Paikkatietojärjestelmät eivät enää nykyisin ole vain yliopistojen ja tutkimuslaitosten työvälineitä vaan niiden käyttöä on pyritty kehittämään myös kouluopetuksessa ympäri maailmaa. Paikkatietojärjestelmiä on alettu hyödyntää erityisesti lukioasteen opetuksessa monissa maissa, kuten Yhdysvalloissa, Tanskassa, Saksassa ja Japanissa. Paikkatietojärjestelmien käyttöä lukioasteen kouluopetuksessa tukee Suomessa uusi lukion opetussuunnitelma, jossa niiden käytön ja perusteiden opetusta velvoitetaan GE 4 Aluetutkimuskurssin kohdalla. Paikkatiedon avulla opettajat voivat edistää oppilaidensa omaan elinympäristöön kohdistuvaa tutkivaa oppimista, tietotekniikan valmiuksien ja medialukutaidon kehittymistä sekä koulunsa integroitumista tietoyhteiskuntaan. Paikkatiedon (GIS) avulla pyritään myös edistämään opiskelijoiden informaatio- ja viestintäteknisiä valmiuksia.

Opetusviranomaisten, kuntien ja yritysten tarjoamat resurssit ja aineistot paikkatieto-opetuksen tueksi vaihtelevat hyvin paljon eri maissa. Valmiiden paikkatietoaineistojen ja paikkatieto-ohjelmistojen saatavuudessa ja soveltuvuudessa opetuskäyttöön on myös suuria eroja. Vaikka paikkatiedon kouluopetusta ollaankin kehittämässä monissa maissa, oppilaitosten ja opettajien tarpeita ja näkökulmia paikkatietojärjestelmien, -ohjelmistojen ja paikkatietodatan suhteen ei ole juurikaan kartoitettu tai tutkittu.

Oheinen kansainvälinen kysely pyrkii tuottamaan tietoa tältä vähän tutkitulta alueelta. Tämä tutkimus toteutetaan suomalais-japanilaisena yhteistyönä ja sen tulokset julkaistaan tieteellisinä artikkeleina suomeksi, englanniksi ja japaniksi vuonna 2007. Tämän 300:lle, pääasiassa lukioiden maantieteen ja biologian, opettajalle lähetetyn kyselyn avulla muodostamme käsityksen siitä, minkälaisia paikkatietoaineistoja ja teemoja sekä paikkatieto-ohjelmistoja oppilaitoksissa tarvittaisiin tai voitaisiin hyödyntää. Samalla pyrimme selvittämään, mitkä ovat suurimmat esteet paikkatiedon hyödyntämiselle oppilaitoksissa. Vastaaminen tämän kyselyn kysymyksiin on helppoa ja suhteellisen nopeaa: vastaaminen tapahtuu valitsemalla alla olevasta lomakkeesta oikea(t) vaihtoehdot ja/tai kirjoittamalla vastaus sille varattuun tilaan. Toivomme, että mahdollisimman moni lomakkeen saanut opettaja vastaisi kyselyyn, jotta saisimme laajan ja luotettavan käsityksen aiheesta. Tällöin tutkimuksen tuottamaa tietoa voitaisiin hyödyntää myös oppilaitoksille tuotettavien paikkatietopalvelujen kehitystyössä ja opettajien täydennyskoulutusta suunniteltaessa.

Vastaaminen kyselyyn tapahtuu Internetissä: tarvitsemme sinusta joitain taustatietoja, koska analysoimme kyselyn tulokset tilastollisesti. Tietoja ei luovuteta eteenpäin ja aineistoa käsitellään kokonaisuutena, joten Sinun henkilökohtaiset vastauksesi eivät ole erotettavissa tuloksista millään tavalla. Kyselylomakkeen täyttäminen vie noin 5-10 minuuttia.

Toivomme, että palauttaisitte kyselylomakkeen näpäyttämällä lomakkeen alaosassa olevaa 'lähetä'-painiketta viimeistään 19.6.2006.

Kiitos vaivannäöstäsi ja mukavaa kesää!

Terveisin,

Tino Johansson
tutkija
Maantieteen laitos
PL 64
00014 Helsingin yliopisto
puh. 09-19151045
tino.johansson@helsinki.fi

Minori Yuda
tutkija
Kartografian ja geoinformatiikan laboratorio
Maanmittausosasto
PL 1200
02015 Teknillinen korkeakoulu
puh. 09-4513924
myuda@cc.hut.fi

Taustatiedot:

Ensimmäiseksi kysytään joitain taustatietoja, jotka ovat tärkeitä tilastollisten johtopäätösten tekemiseksi. Valitse yksi oikea vastaus tai kirjoita vastaus sille varatulle viivalle.

1 . Mikä on sukupuolesi? 1. Mies, 2. Nainen

2. Minkä ikäinen olet? (   )

3. Mikä on äidinkielesi? 1. Suomi, 2. Ruotsi, 3. Englanti, 4. Japani, 5. Muu, mikä? (   )

4. Minkä nimisessä oppilaitoksessa opetat?
(   )

5. Millä paikkakunnalla?
(   )

6. Kuinka monta vuotta olet työskennellyt opettajana?
Vuosia (   )

7. Opetan ensisijaisesti
1. Maantiedettä, 2: Biologiaa, 3: Muuta, mitä? (   )

8. Mitä luokka-astetta pääasiallisesti opetat kuluvana lukuvuonna?
1. Yläasteen 7. luokkaa, 2. Yläasteen 8. luokkaa, 3. Yläasteen 9. luokkaa, 4. Lukion ensimmäistä
5. Lukion toista, 6. Lukion kolmatta, 7. Jotain muuta, mitä? (   )

8-1. Kuinka monta tuntia maantiedettä koulussanne opetetaan tällä luokalla?
Kirjoita alla olevaan kenttään tuntien kokonaismäärä ja tieto kurssien pakollisuudesta tai valinnaisuudesta.
(   )

9. Pääaineeni yliopistossa opiskellessani oli
1. Maantiede, 2. Biologia, 3. Jokin muu, mikä?

10. Sivuaineeni yliopistossa opiskellessani oli/olivat?
(   )

Seuraavaksi kyselyssä halutaan selvittää joitain tämänhetkiseen paikkatieto-ohjelmistojen tuntemukseesi liittyviä asioita.
Vastaa laatikoihin kyllä tai ei ja vastatessasi (kyllä) kirjoita tarkennus sille varattuun tilaan.

11. Ovatko paikkatietoon liittyvät asiat sinulle jo entuudestaan tuttuja? Jos eivät, niin siirry kysymykseen 13.
1. Kyllä, 2. Ei

12. Missä olet tutustunut paikkatietoon? Valitse listasta sopivat vaihtoehdot ja numeroi ne tärkeysjärjestyksessä alla oleviin kenttiin.
( ) Opiskellessani yliopistossa
( ) Julkisen sektorin järjestämässä täydennyskoulutuksessa
( ) Yritysten järjestämässä täydennyskoulutuksessa
( ) Olen opiskellut itsenäisesti paikkatietoa
( ) Jossain muualla, missä? ( )

13. Oletko aiemmin käyttänyt jotain paikkatieto-ohjelmaa? Jos et ole, niin siirry kysymykseen 16.
1. Kyllä, 2. Ei

14. Mainitse nimeltä käyttämäsi paikkatieto-ohjelmat ja arvioi myös käyttöajan pituus.
( )

15. Milloin viimeksi olet käyttänyt jotain paikkatieto-ohjelmaa?
( )

16. Käytetäänkö oppilaitoksessanne paikkatietoa opetuksessa? Jos ei käytetä, niin siirry kysymykseen 22.
1. Kyllä, 2. Ei

17. Mitä paikkatieto-ohjelmistoja käytössänne on?
( )

18. Mistä ja miten saitte nämä paikkatietoohjelmistot käyttöönne?
( )

19. Arvioi, kuinka monena lukuvuotena oppilaitoksessanne on käytetty paikkatietoa?
( )

20. Luettele ne oppiaineet, joiden opetuksen yhteydessä paikkatietoa on oppilaitoksessanne hyödynnetty.
( )

21. Kuinka moni oppilaitoksenne opettajista käyttää paikkatietoa opetuksessaan?
1. Yksi, 2. Kaksi, 3. Kolmesta viiteen, 4. Kuudesta kymmeneen, 5. Yli kymmenen, 6. En tiedä

22. Käytätkö itse paikkatietoa apuna opetuksessasi? Jos et, niin siirry kysymykseen 26.
1. Kyllä, 2. Ei

23. Mihin pääasialliseen tarkoitukseen käytät paikkatietojärjestelmiä opetuksessasi? Valitse vaihtoehdoista sopivat ja numeroi ne tärkeysjärjestyksessä alla oleviin sarakkeisiin.

( ) Havainnollistamiseen valmiiden karttojen avulla
( ) Karttojen tai karttatasojen piirtämiseen
( ) Ominaisuustietojen havainnollistamiseen
( ) Ominaisuustietojen tuottamiseen ja käsittelyyn
( ) Tilastollisten aineistojen analysointiin
( ) Paikkatieto-ohjelmistojen käytön opiskeluun
( ) Tutkivaan oppimiseen
( ) Maantieteellisen ajattelun opettamiseen
( ) Muuhun, mihin? ( )

24. Minkälaista paikkatietodataa käytät ensisijaisesti opetuksessasi? Valitse vaihtoehdoista sopivat ja numeroi ne tärkeysjärjestyksessä alla oleviin sarakkeisiin.

( ) Kaupallista yritysten toimipisteistä ostettua paikkatietodataa
( ) Kaupallista Internetistä ostettua paikkatietodataa
( ) Kaupallista koulukirjojen mukana tulevaa paikkatietodataa
( ) Maksullista viranomaisten tuottamaa paikkatietodataa
( ) Itse tuotettua paikkatietodataa
( ) Opettajaverkostoista peräisin olevaa paikkatietodataa
( ) Ilmaista koulusta saatavaa paikkatietodataa
( ) Ilmaista paikallisilta viranomaisilta saatavaa paikkatietodataa
( ) Ilmaista Internetistä saatavaa paikkatietodataa
( ) Jotain muuta paikkatietodataa, mitä? ( )

25. Kertoisitko vähän tarkemmin mistä ja miten saat käyttöösi edellä mainitsemaasi paikkatietodataa?
( )

26. Mitkä ovat mielestäsi paikkatiedon suurimmat edut opetuksessa?
( )

27. Entä mitkä ovat mielestäsi paikkatiedon opetuskäytön suurimmat ongelmat?
( )

28. Käytätkö Internetissä olevia ilmaisia paikkatietoa hyödyntäviä ohjelmistoja opetuksessasi? Jos et käytä, niin siirry kysymykseen 30.
1. Kyllä käytän, 2. En käytä

29. Millä tavoin käytät Internetistä saatavia ilmaisia paikkatietoa hyödyntäviä ohjelmistoja apuna opetuksessasi?
( )

30. Käytätkö Internetissä olevia ilmaisia paikkatietoaineistoja opetuksessasi? Jos et käytä, niin siirry kysymykseen 32.

1. Kyllä käytän, 2. En käytä

31. Mainitse lyhyesti, millaista Internetistä saatavaa paikkatietoaineistoa käytät opetuksessasi?
Jos haluat, voit antaa myös esimerkkinä osoitteen, osoitteita tai sivustojen nimiä.
( )

32. Montako kertaa yleensä käytät Internetiä apuna paikkatieto-opetuksessa viikon aikana?
1. Kerran, 2. Kaksi, 3. Kolme. 4. Neljä, 5. Päivittäin

33. Paikkatietojärjestelmät soveltuvat mielestäni lukioasteen opetukseen?
1. Kyllä, 2. Ei

34. Paikkatieto-opetuksen tulisi palvella oppilaitoksissa ensisijaisesti.
1. Itsenäistyöskentelyä, 2. Ryhmätöitä, 3. Luento-opetusta, 4. Itsenäistyöskentelyä ja ryhmätöitä,
5. Itsenäistyöskentelyä and luento-opetusta, 6. Ryhmätöitä ja luento-opetusta,
7. Kaikkia kolmea vaihtoehtoa

Valitse seuraavista väittämistä vaihtoehto, joka kuvaa parhaiten tämän hetkistä mielipidettäsi. Vastaa alla oleviin kysymyksiin vaikket käyttäisikään paikkatietoa opetuksessasi.
Vaihtoehdot ovat: Täysin samaa mieltä, samaa mieltä, hieman eri mieltä, täysin eri mieltä ja en osaa sanoa.

35. Hallitsen vähintään yhden paikkatieto-ohjelmiston peruskäytön siten, että voin käyttää sitä opetuksessani apuvälineenä.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

36. Yleisimmissä työasemalle asennettavissa paikkatieto-ohjelmistoissa on riittävästi toiminnallisuuksia opetuksen näkökulmasta.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

37. Internetistä ladattavissa paikkatieto-ohjelmistoissa on riittävästi toiminnallisuuksia opetuksen näkökulmasta.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

38. Oppilaitoksemme lähiympäristöä käsittelevää paikkatietoa on runsaasti saatavilla Internetistä.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

39. Valmiit eri lähteistä saatavat paikkatietoaineistot soveltuvat sellaisenaan omaan opetukseeni.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

40. Paikkatieto-ohjelmistot soveltuvat oppilaitosten opetuskäyttöön, koska niillä voi tuottaa teemakarttoja.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

41. Paikkatietojen avulla voidaan kehittää tutkivaa oppimista oppitunneilla.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

42. Paikkatieto-ohjelmistot ovat yleensä liian vaikeita käyttää.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

43. Paikkatieto-ohjelmistot soveltuvat opetuskäyttöön, koska niiden avulla voidaan tehdä alueellisia analyysejä.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

44. Paikkatieto-ohjelmistot soveltuvat opetuskäyttöön, koska niiden avulla voidaan visualisoida omia havaintoja.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

45. Paikkatieto-ohjelmistot soveltuvat opetuskäyttöön, koska niiden avulla voidaan valita ja luokitella karttakohteita.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

46. Paikkatieto-opetus kehittää oppilaiden ongelmanratkaisukykyä.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

47. Paikkatieto-opetus kehittää oppilaiden spatiaalista (alueellista) ajattelukykyä.
    1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

48. Paikkatietojen käyttö tuo lisäarvoa maantieteen opetukseen.
1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

49. Paikkatietojärjestelmät soveltuvat oppiainerajat ylittävään opetukseen.
1. Täysin samaa mieltä, 2. Samaa mieltä, 3. Hieman eri mieltä, 4. Täysin eri mieltä, 5. En osaa sanoa

50. Mitkä ovat oppilaitoksenne vahvuudet paikkatiedon opetuskäyttöä ajatellen?
( )

51. Entä heikkoudet?
( )

52. Valitse seuraavista vaihtoehdoista neljä toiminnallisuutta, jotka kuvaavat parhaiten tämän hetkistä tarvettasi paikkatieto-ohjelmistojen opetuskäytössä ja numeroi valitsemasi toiminnallisuudet tärkeysjärjestyksessä yhdestä neljään alla olevaan kenttään.
Opetuskäytössä olevilla paikkatieto-ohjelmistoilla tulisi voida:
( ) tarkastella samaa karttaa eri mittakaavoissa
( ) mitata kohteiden välisiä etäisyyksiä
( ) lisätä tekstiä kartalle
( ) tulostaa kartta paperille
( ) muokata karttakohteiden väriä
( ) mitata kohteiden pinta-aloja
( ) visualisoida karttoja kolmiulotteisesti (3-D)
( ) tarkastella kohteiden ominaisuustietoja
( ) laatia etäisyysvyöhykkeitä kohteiden ympärille
( ) tehdä päällekkäisanalyysejä eri karttatasojen tai teemojen perusteella

53. Valitse seuraavista vaihtoehdoista neljä toiminnallisuutta, jotka kuvaavat parhaiten tämän hetkistä tarvettasi paikkatieto-ohjelmistojen opetuskäytössä ja numeroi valitsemasi toiminnallisuudet tärkeysjärjestyksessä yhdestä neljään alla olevaan kenttään.

Opetuskäytössä olevilla paikkatieto-ohjelmistoilla tulisi voida:

( ) tehdä kyselyjä kohteiden sijainnin suhteen
( ) tehdä kyselyjä kohteiden ominaisuuksien suhteen
( ) laatia teemakarttoja
( ) piirtää pisteitä, viivoja ja monikulmioita kartalle
( ) kytkeä ominaisuustietoihin muista lähteistä peräisin olevia tai itse tuotettuja taulukoita
( ) yhdistää ja leikata geometrisiä karttakohteita
( ) muokata kohteiden geometrisiä muotoja
( ) laatia diagrammeja ja taulukoita
( ) yhdistellä erilaisia karttatasoja ja teemoja
( ) paikantaa koulussa kerättyjä havaintoja

54. Valitse seuraavista vaihtoehdoista neljä toiminnallisuutta, jotka kuvaavat parhaiten tämän hetkistä tarvettasi teemakarttojen laadinnassa paikkatieto-ohjelmistojen avulla ja numeroi valitsemasi toiminnallisuudet tärkeysjärjestyksessä yhdestä neljään alla olevaan kenttään.

Opetuskäytössä olevilla paikkatieto-ohjelmistoilla tulisi voida tuottaa teemakarttoihin:

( ) mittakaavajana, ( ) pohjoisnuoli, ( ) kartan selite, ( ) kartogrammeja,
( ) valokuvia ja videoleikkeitä, ( ) tekstiä, ( ) koropleettikarttoja, ( ) pistetiheyskarttoja,
( ) erilaisia symboleja, ( ) erilaisia kohteiden luokittelutapoja

55. Valitse seuraavista paikatietoaineistoista neljä vaihtoehtoa, jotka kuvaavat parhaiten tämän hetkistä aineistotarvettasi paikkatieto-ohjelmistojen avulla opettaessasi ja numeroi valitsemasi vaihtoehdot tärkeysjärjestyksessä yhdestä neljän alla olevaan kenttään.

Tarvitsen opetuksessani erityisesti seuraavanlaisia aineistoja:

( ) aineistoja koulun lähiympäristöstä, ( ) aineistoja kunnasta, ( ) aineistoja läänistä
( ) aineistoja valtiosta, ( ) aineistoja naapurikunnista, ( ) aineistoja naapurilääneistä
( ) aineistoja naapurivaltioista, ( ) aineistoja mantereesta, ( ) aineistoja valtioryhmistä
( ) aineistoja kaikista maailman valtioista

56. Minkälaisia mielikuvia paikkatiedon käyttö maantieteen tai biologian opetuksessa sinussa herättää?

Kuvaile vapaamuotoisesti näkemyksiäsi ja ota kantaa, vaikket olisi ikinä käyttänytkään paikkatietoa.

( )

Lämmin kiitos vastauksestasi!!!

tino.johansson@helsinki.fi